Wage Determination:
An International Perspective

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WAGES

The wages of work is cash.

The wages of cash is want more cash.

The wages of want more cash is vicious competition.

The wages of vicious competition is - the world we live in.

D.H.Lawrence

Contents

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Declaration

Chapter Two of this thesis is based upon joint work with Simon Wren-Lewis which was published as 'Are wages forward looking?', Centre for Labour Economics Discussion Paper no. 375. Chapter Four of this thesis is based upon joint work with Christopher Pissarides which appeared in <u>Wage Formation and Macroeconomic Policy in the Nordic Countries</u>, Oxford University Press, edited by Lars Calmfors.

Abstract

This thesis is an empirical study of wage determination. The research presented here investigates the determinants of wages at several levels of aggregation from the macroeconomic to the individual level. Wage determination in the UK is also compared to that in France and Germany at the aggregate level and to Sweden and the United States at industry level.

It is illustrated that, in the long-run, aggregate earnings in the UK are adequately explained by productivity, short-term unemployment, economic mismatch, direct and indirect tax wedges. However, it is also shown that an index of skill shortages can be used as an alternative to short-term unemployment. This index appears to capture the pressures on pay in the UK more adequately than short-term unemployment and explains a higher proportion of the rise in real earnings during the 1980s. These findings are in sharp contrast with those for France and Germany where we find that the entire pool of the unemployed exerts pressure on wages and that skill shortages have no role to play in determining earnings.

The dynamics of wage inflation are also examined. In particular, encompassing techniques are employed to discriminate between a forward looking and a feedback model of wages for the UK.

At industry level relative wages in Britain, Sweden and the US are compared. It is illustrated that industry wages are more responsive to economy wide, rather than industry specific, performance. Also, relative wages in the US are found to be more responsive to economic variables than in Britain or Sweden.

At the individual level, this thesis presents a time series of cross-section wage equations from the Family Expenditure Survey for the period 1978 to 1985. This analysis reveals that the returns to education and the market value of certain occupational categories have risen over this period, contributing to the rise in real wages. This finding further re-enforces the conjecture that skill shortages have contributed to the rise in real wages in the UK economy.

Preface

Preface

"Productivity is no longer rising fast enough to cover the cost of the higher wages. As a result, our unit labour costs are rising much faster than those of our competitors. So our ability to compete is being damaged... wage settlements need to be lower. It is quite wrong for settlements simply to follow the latest Retail Price Index, that is no indication of what a business can afford."

Margaret Thatcher speaking to the Welsh CBI.
26 September 1990.

The central role that wages play in macroeconomic performance is illustrated by the emphasis which the Prime Minister placed on wage inflation in a recent speech. Throughout the 1980s the rate of increase in average earnings has been consistently above the rate of inflation. The Prime Minister expressed concern that wage inflation could threaten the UK's international competitiveness and lead to higher unemployment. What is the relationship between unemployment and wages which has alarmed the Prime Minister and why is wage inflation in the UK currently so high?

The motivation behind this thesis is to provide answers to at least some of the questions which are raised when discussing the determinants of wages and the causes of wage inflation in the UK. We will also make an attempt to shed some light on wage determination in the UK in the light of international comparisons.

High wage inflation in the 1980s coincided with a resurgence of productivity growth in the UK economy, a phenomenon often referred to as the 'productivity miracle'. Figures from HM Treasury (1989) indicate that between 1980 and 1988 productivity, measured as output per person employed, grew at an average rate of 2.5 per cent per year in the UK, well above the average growth rate of 1.8 per cent for the Group of Seven (G7) industrial nations. Could it be that the high rate of wage inflation in the UK is justified by the better than average productivity performance?

At the same time, the corporate sector enjoyed healthy profits. It can thus be argued that the firms could afford to pay higher wages. What is the relationship between corporate profits and pay?

In the speech quoted above, the Prime Minister maintained that there was no reason for wage settlements to follow the latest Retail Price Index. After all, wages played a central role in the downfall of Mrs Thatcher's predecessors. A wage-price spiral not only brought about the collapse of the Heath government in 1974 but also set the scene for the 'winter of discontent' in 1979, leading to the demise of the last Labour government. Curbing price inflation has been the corner-stone of the government's economic policy throughout the 1980s. However, until very recently wages have continued to outpace the rate of increase in prices. What is the relationship between prices and wages? Why is it that controlling price inflation has had no bearing on wage inflation?

Between 1980 and 1986 unemployment rose from about 1.6 million to a peak of 3.3 million (12 per cent of the work force). Disregarding the numerous official changes in the definition of unemployment, this represents a rise of over 100 per cent. During this period the labour market could hardly have been considered tight, yet wage inflation during this period never fell to below 5 per cent per annum. While unemployment was rising the number of unfilled vacancies was also on the ascent: between 1981 and 1986 the number of unfilled vacancies notified to job-centres rose by some 90 per cent. Furthermore, in 1986 when unemployment stood at its highest level since the 1930s, the Confederation of British Industry's Industrial Trends Survey reported that over 10 per cent of British firms had indicated that their output was constrained by a shortage of skilled labour. Rising vacancies and skilled labour shortages during a period of unprecedented unemployment pose some important questions. What are the roles of vacancies and skill shortages in the determination of wages? How can we reconcile high unemployment and rising wages?

Rising unemployment was by no means confined to Britain during the first half of the 1980s. Most other industrial nations also experienced unprecedented levels of unemployment. In France unemployment rose to 10 per cent of the work force and in Germany to 8 per cent. However, the experience of wage inflation in the British economy was rather curious during this period. According to OECD calculations, between 1980 and 1986, when UK unemployment rose continuously, real wages (average hourly earning deflated by the consumer price index) rose by about 30 per cent whereas they rose by some 12 per cent in France and by only 7 per cent in Germany. Why is wage inflation so much higher in the UK than elsewhere in the European Community?

The answer to this question is particularly relevant in the light of Britain's entry into the Exchange Rate Mechanism (ERM) of the European Monetary System in October 1990. It may be argued that firms faced with the discipline of a fixed exchange rate band, imposed by the ERM, will resist excessive wage demands. Wage inflation in the UK should then converge to the lower level experienced in Germany. The experience of France, which joined the ERM in the early 1980s will, no doubt, be instructive. However, if the determinants of wages differ significantly between the UK, France and Germany, ERM entry may not necessarily lead to lower wage inflation in the UK. Wage determination will therefore continue to be of crucial importance to the performance of the UK economy in the 1990s.

In a broader international comparison of wages, Sweden and the United States represent interesting examples. Between 1980 and 1986 real wages in Sweden rose by a mere 3 per cent and in the US by only 5 per cent. Interestingly, unemployment in these two countries never reached the peaks attained by the UK, France or even Germany. In the US, the unemployment rate peaked at 7.5 per cent in 1984 before falling sharply and in Sweden it has never exceeded 3.1 per cent. Could it be that real wages are more flexible in Sweden and the US than in the UK and that this is the reason for lower unemployment?

A discussion of wages at the aggregate level conceals the degree of variation in earnings and in earnings growth in the UK economy. In practice, there are stark regional, occupational and industrial disparities. For example, between 1980 and 1985, while unemployment was rising, real weekly earnings in electrical and electronic engineering, printing and publishing as well as banking, finance and insurance rose by about 40 per cent. During the same period real weekly earnings in the coal industry fell by 5 per cent. Could we explain part of the upsurge in wage inflation throughout 1980s by a shift in the regional, occupational or industrial pattern of wages?

One notable feature of the labour market in the 1980s was an increase in the demand for graduates as indicated by the rise in graduate starting salaries. A report by the Institute of Manpower Studies (1988) showed that starting salaries for new graduates rose from 67 per cent of average male earnings in 1982 to 77 per cent in 1987. This raises the question as to whether or not the returns to education have risen, and if so, what contribution this has made to wage inflation.

The following chapters of this thesis aim to provide answers to at least some of the questions raised above.

Given the importance of wages in the analysis and forecasting of economic developments, considerable work has been done on modelling and analysing the determinants of wages since Phillips' seminal 1958 paper. The theoretical and empirical interest in wages has been invigorated by the rapid rises in wage inflation in the 1980s which have occurred in spite of unprecedented levels of unemployment.

In Chapter One we present a survey of the theories of wages. The purpose of this chapter is to build a firm theoretical foundation for the empirical analysis of the subsequent chapters as well as to identify the theoretical determinants of wages.

Although, as we shall see, there has been little dispute about the theoretical framework within which wages are determined, there has been no universal agreement about the empirical determinants of wages. Since the early 1980s scholars have attempted to explain high wage inflation in the UK by trying to identify the 'missing variable' in the wage equation. Their work has been valuable and, at times, controversial. Chapter Two discusses some of the ideas which have been put forward to explain the phenomenon of wage inflation before proceeding to discriminate between them. In this chapter we also pay special attention to the dynamics of wages. In particular, with the aid of recent encompassing techniques, we test a forward looking model, which assumes that agents form rational expectations about future price inflation, against a data generated model dependent on past price inflation.

We then proceed, in Chapter Three, to examine our findings for the UK in a European context. We present estimates of a wage-productivity system for the UK, France and Germany. In particular, we examine the influence of skill shortages on wage inflation in the three countries. As the UK's main European competitors, France and Germany provide us with an interesting comparative framework and help to shed some light on cross-country differences. Recently, both countries have experienced lower wage inflation than the UK. The experience of France is of particular relevance given Britain's recent membership of the ERM.

Aggregate studies often disguise the degree of variation of wages across the economy. Therefore, we devote the remaining two chapters to a more disaggregated study of wages. In Chapter Four we study wages at industry level. We concentrate on assessing whether relative industry wages respond to relative sectoral performance in the UK, the United States and Sweden. The latter two countries are often cited as examples of economies with flexible wages. We mentioned above that in contrast to the UK, the US and Sweden experienced small rises in real wages and unemployment during the first half of the 1980s. Furthermore, Sweden and the US symbolise the two extremes of a corporate economy. The United States is regarded as the champion of free enterprise with a competitive economy and a very small union sector, whilst Sweden is considered the model corporate economy with high unionisation and relatively centralised bargaining, although this is beginning to change. Together therefore, Sweden and the United States provide a good yardstick against which the UK can be measured. Furthermore, industry level data for the US and Sweden is readily comparable with that available for the UK.

We pursue our disaggregated analysis of wages further in the final chapter of this thesis. Chapter Five investigates the determinants of individual level earnings with the assistance of data from the Family Expenditure Survey (FES). In this chapter we assess the returns to education, occupation, region and industry in Great Britain. Furthermore, in an attempt to account for the substantial rise in real wages, Chapter Five presents a time series of cross-section wage equations from the FES for the period 1978-1986.

In the final section, we summarise the main findings of the thesis and draw some conclusions regarding the implications of this thesis for economic policy.

Chapter One

Wage Determination: A Theoretical Perspective

1.1 Introduction

The rise and demise of the Phillips curve

A good starting point for the study of wages is the seminal 1958 paper by Phillips. The central contribution of this pioneering article was to reveal the effect of the level of unemployment on wage inflation. The theory underlying Phillips' analysis is based on the notion of excess demand in the labour market. He argued that employers bid up money wage rates when unemployment is low in order to attract labour from other firms. He also observed that the relationship between unemployment and the rate of change of wage rates is likely to be highly non-linear, thus unemployment would have a diminishing marginal impact on wages. Phillips also postulated that wage inflation would depend on the rate of change of the demand for labour and hence on changes in unemployment. Phillips' wage equation, the "Phillips Curve", can be written as:

$$\Delta w = f(U, \Delta U) \tag{1.1.1}$$

Phillips used the following functional form:

$$f(U, \Delta U) = \alpha + \beta U^{\delta} + \gamma(\Delta U/U) \tag{1.1.2}$$

However, he did not estimate equation (1.1.1) above by econometric methods, instead he used an averaging process over business cycles which eliminated $\Delta U/U$. He then estimated the parameters α, β and δ by trial and error to obtain:

$$\Delta w = -0.900 + 0.638\ U^{-1.394} \tag{1.1.3}$$

Phillips' work concurrently captured the imagination of economists on both sides of the Atlantic. Lipsey (1960) offered both a theoretical underpinning for the 'Phillips curve' and an econometric estimate of a linearised version of (1.1.2) for the UK. While Samuelson and Solow (1960) estimated the Phillips curve for the US and provided a set of policy alternatives demonstrating the trade-off between different levels of unemployment and price inflation.

Lipsey's theoretical argument for the non-linearity of the Phillips curve is based on the existence of many micro labour markets, say, on the basis of skills, some of which are facing excess demand for labour while others were at the same time experiencing an excess supply of labour. This leads, upon aggregation, to non-linearity in the relationship between changes in the price for labour, wages, and the excess demand for labour represented by unemployment.

However, it was not the theoretical foundation of wage determination which became the focus of research for the next two decades but Lipsey's inclusion of the change in prices as a determinant of change in wages. He estimated:

$$\Delta w = \alpha_0 + \alpha_1 f(U) + \alpha_2 \Delta U + \alpha_3 \Delta p_c \qquad (1.1.4)$$

The issue at the centre of theoretical as well as empirical research became the value of α_3. The existence of a long-run trade-off between unemployment and wage inflation depended on α_3 being less than unity. Sargan (1964) estimated a wage-price system and pointed out that, at least in the long-run, the Phillips curve has to be about real and not nominal wages. Sargan focused on the econometric issues involved in estimating time series models with autocorrelated errors. He did not put forward a theoretical framework for his wage-price system, but his insight was extended in a number of theoretical works by other authors.

Friedman (1968) and Phelps (1968) argued that the labour market determined real and not nominal wages and that in the long-run there were no money illusions. Demand and supply of labour, they argued, were determined by real and not nominal wages. The expectations augmented Phillips curve with unit coefficient on price changes can be obtained by re-writing (1.1.1) as:

$$\Delta(w-p) = \Delta(p^e-p) + f(u,\Delta u) \qquad (1.1.5)$$

Over the years there have been numerous empirical applications of (1.1.5) with varying degrees of success. It is probably fair to say that equation (1.1.5) has performed better when applied to US rather than UK or European data. Blanchard and Summers (1986) attribute this to periods of sustained high unemployment in Europe.

The expectations augmented Phillips curve, (1.1.5) together with a price equation, such as (1.1.6), formed the "wage-price" mechanism and were for many years the basis of macroeconomic model building when it came to wage determination. In (1.1.6), y-n, output per head, represents labour productivity.

$$\Delta p = \Delta w - \Delta(y-n) + g(U) \qquad g'<0 \qquad (1.1.6)$$

Nickell (1984) has a number of interesting examples of this. He notes that in the early 1980s the Treasury wage equation contained lagged wages, retail prices, producer prices, income taxes, employment taxes, output, unemployment, government employment and company income with lags of up to and including 9 quarters. The London Business School equation for wages included producer prices, import and export prices, output, employment, potential employment and money stock. At the same time, the National Institute wage equation contained lagged wages, retail prices and income taxes. Nickell points out that all three modelling agencies had the rate of change of money wages as the explanatory variable.

The dissatisfaction with the wage-price mechanism stemmed both from its poor empirical performance in the light of rising levels of unemployment in Western Europe, and from theoretical concerns about the determination of wages in the labour market.

Consider the Phillips curve in (1.1.5), if there is an unanticipated price rise, then the coefficient on p would be larger than that on p^e and the real wage would fall permanently. This is at odds with other models, e.g. Fischer (1977), which do not generate permanent changes in the real wage as a consequence of temporary shocks.

The Phillips curve itself does not incorporate productivity, this appears in the price equation. During the 1980s we have seen rising productivity together with higher unemployment and increases in real wages. This cannot be explained by the wage-price mechanism. Suppose there is a rise in productivity, this leads to lower price inflation, through (1.1.6), given wage inflation. Unemployment has to fall to allow for a higher rate of wage inflation given price inflation.

Nickell (1984) argues that the theoretical deficiencies of the wage-price mechanism in general, and the Phillips curve in particular, stem from the fact that the existence of the market for labour is totally ignored. The notion of a labour market helps us to think in terms of the joint determination of wages and employment. In Nickell's words we must "drag the wage equation out of the wage-price sector and back into the labour market where it belongs" if we are to have a satisfactory theoretical foundation for determination of wages.

Since the late 1970s there has been an upsurge of theoretical work on the determination of wages within the framework of the labour market.

This was undoubtedly sparked off by the recognition that a lucid knowledge of wage determination is an essential part of understanding the causes behind the unprecedented levels of high unemployment. In particular, scholars have tried to explain real wage rigidity. The question they have attempted to address is why shifts in the demand for labour lead to fluctuations in employment rather than movements in the real wage.

In the following sections we briefly review a number of theoretical models of wage determination. This is a very large field in itself and it could easily occupy the entire thesis. However, since our interest is primarily empirical, the aim of the following sections is to identify clearly the variables which would enter a wage equation before proceeding to estimation.

We explore three types of models. The first which falls under the general heading of "union bargaining" models, examines the ramifications of the fact that unions or "insiders" through bargaining with the firm can set a real wage-employment outcome different to that which would be observed under perfect competition. The second type of model, which falls under the general heading of "efficiency wages", investigates the consequences of assuming that the real wage may be related to the quality of labour. We finally explore the "implicit contract" models which are based on the notion that firms can provide their workers with insurance against income uncertainty. However, before we proceed to exploring these models we have to acknowledge that the reference point for any theory of wage determination has to be the competitive outcome.

1.2 The market clearing model

The economics of vicious competition

The simplest model of wage formation is probably that of market-clearing, where the demand and supply for labour determine the wage and the level of employment. Here we shall briefly sketch a simple classical model along the lines suggested by Nickell and Andrews (1983) and Nickell (1984). Fundamental to the analysis are the supply and demand schedules.

The classical theory of labour supply and consumption originated in the work of Irving Fisher in the 1920s. The modern formulation of this theory is articulated in the intertemporal optimization model of Lucas and Rapping (1969). At time t in this model the household faces exogenous sequences of money wages $\{W_{t+j}\}_j$, consumption prices $\{P_{t+j}\}_j$ and the discount factor $\{\beta_{t+j}\}_j$, where $j=0\ldots\infty$ and $\beta_t=1$. The household chooses a sequence of labour supply and consumption, $\{N_{t+j}, C_{t+j}\}_j$, that maximises the utility function

$$U(\{C_{t+j}\}_j, \{N_{t+j}\}_j) \qquad j=0\ldots\infty \tag{1.2.1}$$

subject to the household budget constraint

$$\sum_{j=0}^{\infty}(\beta_{t+j}W_{t+j}N_{t+j} - \beta_{t+j}P_{t+j}C_{t+j}) = 0. \tag{1.2.2}$$

It is assumed that the utility function U is increasing in consumption and decreasing in employment with diminishing marginal utility of consumption and increasing marginal disutility of work.

The Lucas and Rapping optimization can be solved to obtain a labour supply equation of the form

$$N_s = N^s(W(1-t_2)/P_c, Z, W^*, \exp(R)) \tag{1.2.3}$$

in log linear form:

$$n^s = \beta_0 + \beta_1(w-t_2-p_c) + \beta_2 z + \beta_3 w^* + \beta_4 R \qquad (1.2.4)$$

where $\beta_1>0$, $\beta_2>0$ and $\beta_3>0$; lower case letters indicate logs. P_c is the consumption price deflator, W^* is the normal real wage which is assumed to be the weighted sum of expected future real wages, t_2 the income tax rate and R the real rate of interest. Z can be regarded as incorporating all the exogenous factors which affect the supply of labour such as unemployment benefits.

It is interesting to note that fluctuations in the current real wage or the rate of interest could lead to large changes in the labour supply due to the intertemporal substitutability of work and leisure.

Let us assume that the demand for labour follows from profit maximising behaviour by firms subject to a Cobb-Douglas production function. Firms maximise:

$$\pi = P_f F(N, M, K) - P_m M - W(1+t_1)N \qquad (1.2.5)$$

Thus, the long-run demand for labour can be considered to be a function of the real wage, input prices and the capital stock:

$$N^d = N^d(W(1+t_1)/P_f, P_m/P_f, K) \qquad (1.2.6)$$

in log linear form:

$$n_d = \alpha_0 + \alpha_1(w+t_1-p_f) + \alpha_2(p_m-p_f) + \alpha_3 k \qquad (1.2.7)$$

where lower case letters indicate logs. W is the nominal wage, P_f is the gross output price, P_m the price of materials, $t_1 \simeq \log(1+t_1)$ the employment tax rate. Labour demand is thought to be a negative function of the wage and input prices as well as a positive function of the capital stock.

There are a number of points worth noting. There is no constraint on output, otherwise output would appear as a determinant of the demand for labour. To apply the above labour demand equation to macroeconomic data, we have to assume that aggregation over all firms is possible. This is a long-run equation and thus has no lag structure. However, if there are costs of adjustment associated with changing employment, not only will lags appear but also the demand for labour will depend on future expectations of the price variables. This is illustrated by Sargent (1978) and is worth re-examining in the light of the recent debate about whether agents look forward or use backward looking rules of thumb, e.g., Hendry (1988).

In the competitive framework wages are assumed to act as the adjustment mechanism equating the supply and demand for labour. Equating n^s and n^d we have

$$w-p_c = (\beta_1-\alpha_1)^{-1}[(\alpha_0-\beta_0)+\alpha_1 t_1+\alpha_1 t_3+\alpha_1 t_2+\alpha_2(p_m-p_f)+\alpha_3 k-\beta_2 z-\beta_3 w^*-\beta_4 R] \tag{1.2.8}$$

where

$$p_c = p_f+t_3 \tag{1.2.9}$$

It is worth noting that product real wage $W^P = W(1+t_1)/P_f$ while the consumption real wage $W^c = W(1-t_2)/P_c$. Now equating the nominal wage we have:

$$W^c = ((1-t_2)/(1+t_1)(1+t_3))W^P \simeq (1-t_1-t_2-t_3)W^P = (1-T)W^P \tag{1.2.10}$$

where T, the total tax wedge, is defined as:

$$T = t_1+t_2+t_3 \tag{1.2.11}$$

this is the relationship between the consumption wage and the product wage.

The classical market clearing model determines the real wage in terms of tax wedges, real material prices, the capital stock, the real rate of interest, normal wages and other exogenous factors affecting the supply of labour. We must note that some of these variables, such as prices or the capital stock, may be endogenously determined.

Aggregate demand or fiscal policy may influence the real wage and hence the level of employment only to the extent that they may affect the real interest rate.

The market clearing or full equilibrium approach adopted above assumes that the real wage is determined so that $N=N^s=N^d$; note that we only observe N. This assumption can be replaced by that of imperfect competition in which case the above analysis will remain essentially unaltered bar the fact that we can directly introduce a measure of aggregate demand as a determinant of labour demand in (1.2.7). Imperfect competition can be regarded as assuming that the market is dominated by a monopolist and that we only observe points on a demand curve, in other words $N=N^d$.

The above wage equation may also be regarded as the long-run solution of a disequilibrium system such as those estimated by Nickell and Andrews (1983) or Hall and Henry (1988). The unique feature of the disequilibrium models is that they assume that the observed level of employment is always on the short side of the market:

$$N = \min (N^s, N^d) \qquad (1.2.12)$$

This model is based on the notion that the demand or supply of labour may be thought of as the maximum amount that can be employed at any given real wage. To have a complete model of wage determination it is necessary to make an assumption about the adjustment of the real wage:

$$(W/P)_t = (W/P)_{t-1} + \gamma(N^d-N^s) \qquad (1.2.13)$$

so that if the demand is greater than the supply of labour then real wages would rise and vice versa. Therefore, over time, the real wage would adjust to the market clearing level but the speed of adjustment would depend on γ: if γ is small then disequilibrium could persist for a considerable time.

In the market clearing framework wage rigidity could arise if the labour supply schedule is very elastic. In terms of the above model this will occur if β_1 is very large. In this case the coefficient $(\beta_1-\alpha_1)^{-1}$ in the wage equation would tend to zero and thus changes in the demand for labour would have little influence on the real wage.

In the 1970s a number of scholars developed alternative theories to explain real wage rigidity in the face of fluctuations in employment. One such theory explores the notion of an 'implicit contract' between the workers, who prefer a steady income rather than face the risk of becoming unemployed, and the employer, who is prepared to take a risk and insure the worker against loss of employment in return for higher average profits.

1.3 The implicit contract model

Making wage rigidity explicit

At the heart of the first generation of implicit contract models is the assumption that the firm and its workforce have different attitudes towards taking risk. Azariadis (1975), Baily (1974) and Gordon (1974) formulated this basic insight within optimization models to show that wages can be rigid over an economic cycle while employment could fluctuate.

Here we formulate a very simple implicit contract model in order to highlight the basic implications of wage determination within this category of models. Suppose that workers are risk averse but they cannot insure themselves against the uncertainty of becoming unemployed and losing their income. By contrast, the firm is assumed to be risk neutral because, say, it has access to capital markets. Under these conditions the firm may provide its workforce with insurance through agreeing on a wage-employment schedule. The workers accept a guaranteed fixed wage, while the firm takes a risk in return for higher average profits.

Let us first consider the contract which would emerge between one firm and one worker. We assume that the worker aims to maximise a utility function of the form expressed in (1.2.2):

$$U(C-G(L)) \qquad U'>0,\ U''<0,\ G'>0,\ G''>0 \tag{1.3.1}$$

subject to:

$$C = wL \tag{1.3.2}$$

where C is consumption, w is the real wage and G is a function of L, units of labour supplied. The risk neutral firm maximises its expected profits, Π, subject to the production function Y:

$$\Pi = sY(L) - wL \qquad Y'>0,\ Y''<0 \tag{1.3.3}$$

here the output of the firm is sY(L) where s is a random variable representing unforeseen shocks. Each value of s represents a "state", say, of boom or slump. First consider the competitive equilibrium. Maximising the worker's utility function we have the labour supply:

$$w = G'(L) \tag{1.3.4}$$

while maximising the firm's profit function will give the labour demand schedule:

$$w = sY'(L) \qquad (1.3.5)$$

therefore in equilibrium:

$$sY'(L) = G'(L) \qquad (1.3.6)$$

thus the equilibrium wage and units of labour depend upon s, if we move from a boom to a slump then both the w and L will alter:

$$L^{*}=f_1(s),\ w^{*}=f_2(s). \qquad (1.3.7)$$

The firm is risk neutral, so it can offer a contract to the workers which transfers income between states and increases the utility of the worker. This contract can be characterised as the $\{C(s),\ L(s)\}$ combination which maximises:

$$[sY(L) - C] + \lambda[U(C-G(L)] \qquad (1.3.8)$$

maximising with respect to L and C gives:

$$sY'(L) - \lambda U'G'(L) = 0 \qquad (1.3.9)$$

$$-1 + \lambda U' = 0 \qquad (1.3.10)$$

the second condition indicates that a worker's marginal utility is equalised across states. This does not mean that real wages are necessarily equalised; we shall return to this point later. If we substitute for U' from (1.3.10) into (1.3.9), then we will obtain (1.3.6). This shows that employment and therefore output are exactly the same under the contract as in the competitive outcome.

This simple model indicates that under an implicit contract, the pattern of employment and output would not differ from a competitive outcome but that the real wage would diverge from a competitive equilibrium so that workers' marginal utility would be equalised across booms and slumps.

Now suppose that the contract is between N workers and the firm rather than just the one worker and the firm. For simplicity we assume that each worker supplies either one or zero units of labour, i.e., $L=0$ or 1. Since $C=wL$, we can re-write the optimization problem as

$$\text{Max } [sY(N) - wN] + \lambda[NV(w) + (1-N)V(b)] \tag{1.3.11}$$

where b is the real level of unemployment benefits. Now maximising with respect to w and N:

$$-N + \lambda NV'(w) = 0 \tag{1.3.12}$$

$$(sF'(N) - w) + \lambda(V(w) - V(b)) = 0 \tag{1.3.13}$$

(1.3.12) can be simplified to give:

$$V'(w) = 1/\lambda = \text{constant} \tag{1.3.14}$$

Therefore the optimal labour contract will make the marginal utility of wages constant. Given our assumptions about the shape of the utility function, there will be only one wage rate which would satisfy (1.3.14). The real wage is thus absolutely rigid. Also, if the aim of the contract is to equalize workers' utility across the states of boom and slump, then we must have $V(w)=V(b)$. So from (1.3.13) employment will be the same as that prevailing under a perfectly competitive spot market equilibrium. Thus the model exhibits wage rigidity while employment fluctuates, as it would in the spot market.

So far we have made three simplifying assumptions. Firstly, we have implicitly assumed that the utility function is restrictive enough not to have income effects. Secondly, the firm is considered to be risk neutral but the workers risk averse. Thirdly, we have assumed that both the firm and the workers are fully informed about the state of the world, s. What happens if we relax these conditions?

Suppose we allow for income effects. The implicit contract between the firm and the workers increases the income of the workers in the slump state relative to their income without a contract. The marginal utility of leisure will be higher and the contract decreases the income effect on labour supply. This is in line with the intertemporal substitution models mentioned in Section 1.2, however, the income effects suggest that the unemployed are better off than the employed!

Under asymmetric information the implicit contract model exhibits rather odd characteristics. Suppose the firm has an information advantage so that it knows the value of s but the workers do not. If the workers are not fully aware of the product market conditions then they will need an observable proxy to guard themselves against being cheated by the firm. Employment is observable and can be a suitable proxy of variation in the product market conditions faced by the firm. To guard themselves against the risk of unemployment, the workers force the firm to have a higher level of employment than it would choose to have under spot market conditions. Furthermore, Grossman and Hart (1981) show that more general implicit contract models do not predict wage inflexibility.

These models can be seen to give credence to the view that the observed fluctuations in output and employment are really optimal. Accordingly, the problem of high unemployment can be explained rather than solved. It is ironic that more complex versions of the implicit contract model, whose original aim was to explain wage rigidity, not only do not predict wage inflexibility but also easily deliver overemployment instead of involuntary unemployment. The implications of the implicit contract model are at times incongruous and self contradictory. From an empirical point of view it may be more fruitful to explore the nature of the bargaining between firm and workers with the aim of identifying the economic forces at work when it comes to determining wages. This is what we shall turn to next.

1.4 Union bargaining models

The Firm's "right-to-manage"

Despite the decline in trade union membership during the 1980s collective bargaining is still prevalent in the British economy. Table 1.4.1 illustrates that large numbers of workers are members of trade unions. In 1988 over 10 million British workers were trade union members. Collective bargaining also encompasses a large number of non-union workers whose wages are covered by trade union agreements. For instance, according to the New Earnings Survey, 70 per cent of manual workers were covered by trade union agreements in 1985.

Table 1.4.1

Trade union membership in the United Kingdom

	1978	1980	1982	1984	1986	1988
membership (thousands)	13,112	12,946	11,593	10,994	10,539	10,238

Source: DE Gazette, May 1990

Thus any realistic model of wage determination must incorporate this aspect of the labour market. Indeed, since the late 1970s there has been an incredible upsurge of work in this area. We will explore two basic frameworks which dominate this literature, the right-to-manage model and the efficient bargaining model. Our aim again is to employ models of the labour market to identify the variables which affect the determination of wages.

The right-to-manage model was first put forward by Nickell (1982) and builds upon the union monopoly model and the labour demand schedule, both of which are special cases of this model. The critical assumption behind the right-to-manage model is that although the firm and the union bargain over wages, the firm reserves the right to set employment.

Let us assume that the union aims to maximise the utility of a representative member. Each member either works supplying one unit of labour, or does not work. U(w) is the utility derived from the real wage net of the disutility of work. U(b) is the utility derived from not working or receiving the reservation wage. Let N be the number of employed workers and M membership of the union. We assume that the workers are homogeneous so the union aims to maximise:

$$U = (N/M)U(W) + (1-N/M)U(b) \tag{1.4.1}$$

or alternatively

$$U = U(b) + (N/M)[U(W)-U(b)] \tag{1.4.2}$$

where U(.) is a concave utility function. If we suppose that M and b are exogenous then we can assume that the union maximises:

$$U = N[U(W)-U(b)]. \tag{1.4.3}$$

Figure 1.4.1 Union indifference curves

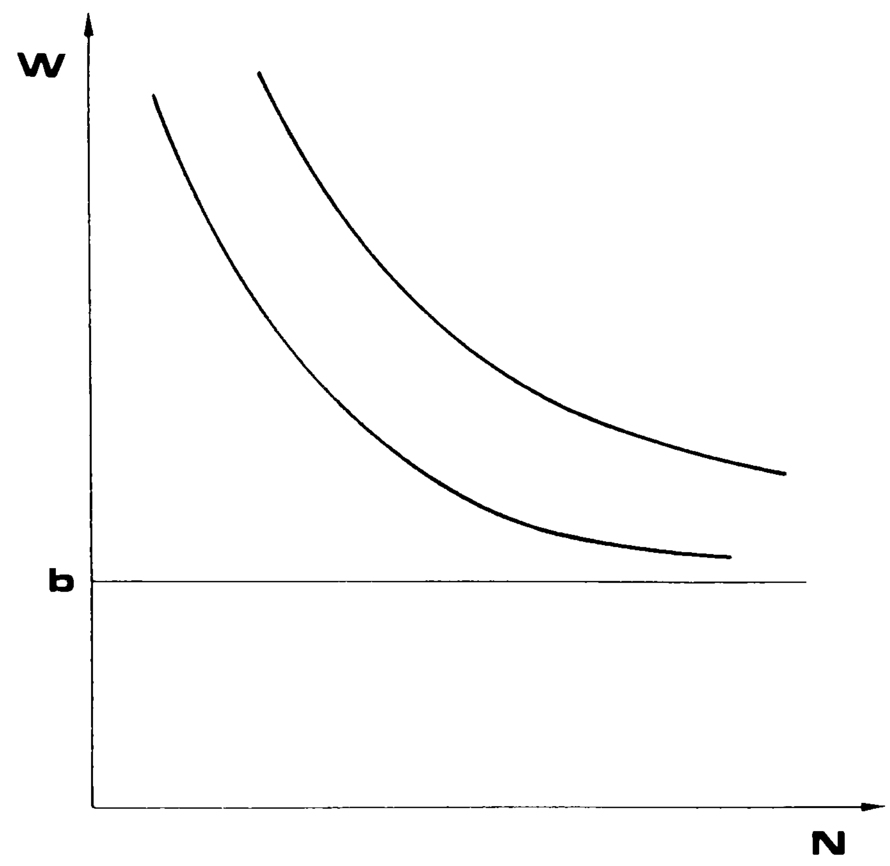
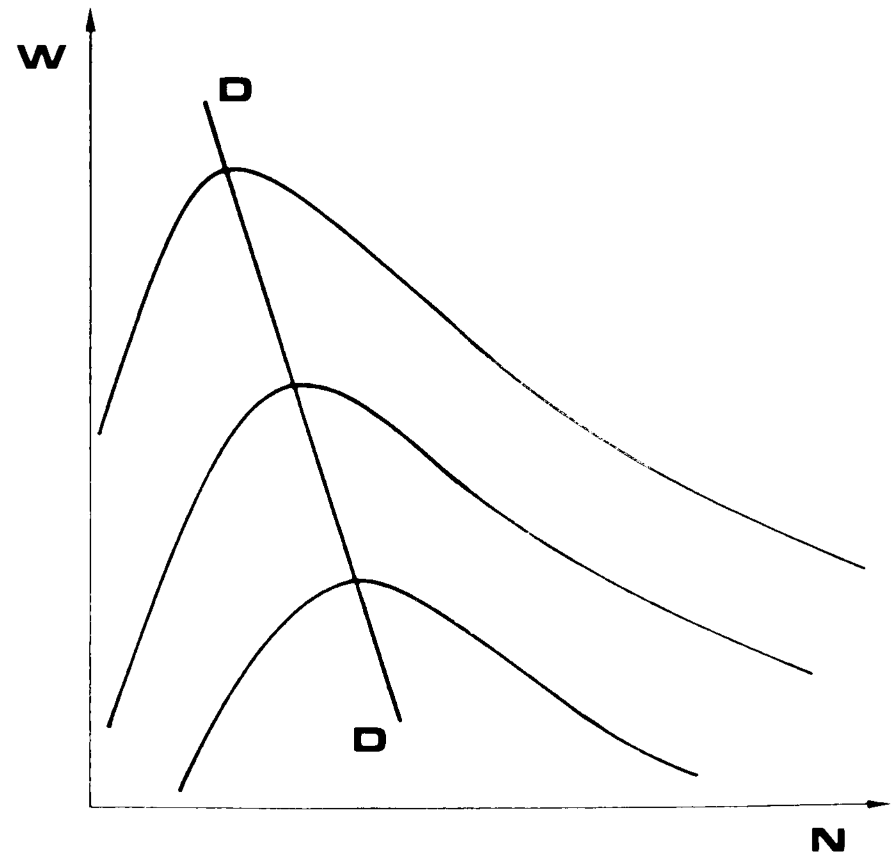


Figure 1.4.2 The firm's iso-profit contours



Now suppose that the firm operates in an imperfectly competitive output market so that it makes positive profits and is not a price taker. The firm employs N union members at a wage of W and has a production function with a positive and decreasing marginal return to labour:

$$Y = F(N) \qquad F'>0,\ F''<0 \qquad (1.4.4)$$

and so will aim to maximise its profits:

$$\Pi\ (W,N) = R(N) - WN \qquad R(N)=pF(N),\ R''<0. \qquad (1.4.5)$$

It is instructive to derive the iso-profit contours of the firm; totally differentiating (1.4.5) we have

$$d\Pi = R'(N)dN - WdN - NdW \qquad (1.4.6)$$

Taking W^* as given, profit maximisation gives

$$d\Pi/dN = R'(N) - W^* = 0 \qquad (1.4.7)$$

Thus the firm sets the level of employment N^* such that

$$N^* = R'^{-1}(W^*) \qquad (1.4.8)$$

i.e., the labour demand schedule.

We note that the slope of the iso-profit curve is given by

$$\frac{dW}{dN} = \frac{R'(N) - W}{N} \qquad (1.4.9)$$

and the slope of the labour demand is

$$\frac{1}{R''(N)} < 0 \qquad (1.4.10)$$

Accordingly, the iso-profit contours have an inverse U shape as shown in Figure 1.4.2. For a given N, the lower the wage, the higher the profits. For a given wage, profits initially increase as employment is increased since the marginal revenue product is above the wage. This happens up to the point where profits are maximised ($R'(N)=W$), thereafter any increases in employment reduce profits. Furthermore, the locus of the maxima of the iso-profit contours is the labour demand schedule $(N=R'^{-1}(W))$.

Let us employ the generalised Nash bargaining concept, in which case the wage outcome of the right-to-manage bargaining would be that which maximises:

$$\max_{W} \{N[U(W)-U(b)]\}^{\alpha} \{\Pi-\Pi_0\}^{1-\alpha} \tag{1.4.11}$$

where α is the bargaining strength of the union and Π_0 is the level of fall-back profits. The first order condition then gives:

$$\frac{\alpha WU'(W)}{[U(W)-U(b)]} = \alpha\epsilon + \frac{(1-\alpha)WN}{\Pi} \tag{1.4.12}$$

where $\epsilon=-[WN'(W)/N]$ is the wage elasticity of demand for labour.

(1.4.12) represents the costs and benefits of increasing wages. The left-hand side represents the proportionate increase in workers' utility from a one per cent increase in real wages. This is multiplied by the union's bargaining strength, α. The percentage cost consists of two terms. The first is the percentage decline in employment represented by ϵ, the wage elasticity of employment. The second is the percentage change in the profits of the firm as a result of a change in the real wage. This term is multiplied by $(1-\alpha)$ which is the bargaining strength of the firm.

The real wage derived from (1.4.12) will depend on the parameters α, b, Π_0, p and on any other variables which determine α, b, p and Π_0. Let us look at these variables more closely.

If $\alpha \longrightarrow 0$, then the union will have no bargaining power. The wage-employment outcome will be solely determined by the firm maximising its profit as expressed by (1.4.5). The outcome will be on the labour demand curve (1.4.8).

If $\alpha \longrightarrow 1$, then the firm will have no bargaining power. The wage-employment outcome will be determined by the union maximising its utility (1.4.3) subject to the firm's labour demand curve (1.4.8). This special case of the right-to-manage model is known as the "union monopoly" model. The origin of the union monopoly model can be traced back to Dunlop (1950). It is interesting to note that in the union monopoly model the second term on the right-hand side of (1.4.12) disappears, the firm is left with no surplus profits, so the gain to the union from a one per cent increase in wages is simply counter-balanced by the proportionate fall in employment.

An increase in U(b) raises the proportionate gain in utility on the left-hand side of (1.4.12) and thus raises the real wage; this can be shown formally by differentiating the first order condition with respect to b. An increase in unemployment could limit the opportunities for workers to work in other sectors of the economy and thus lower U(b), this will lead to a fall in real wages and a rise in employment.

What happens to wages if the price of the firm's product rises? Profits will no doubt rise but so would the demand for labour. Again, the first order condition shows that wages will be independent of the firm's prices if the wage elasticity of demand for labour is independent of p.

Finally, the main drawback of the right-to-manage model is that the wage-employment outcome is not Pareto-efficient. Both the employer and the workers could be better off by choosing an outcome such as B in Figure 1.4.3 rather than the actual bargain at A. At B the firm is on a higher iso-profit contour and the union attains a higher utility. This inefficiency has encouraged scholars to consider models with Pareto-efficient outcomes.

Figure 1.4.3 Pareto-inefficiency of the right-to-manage model

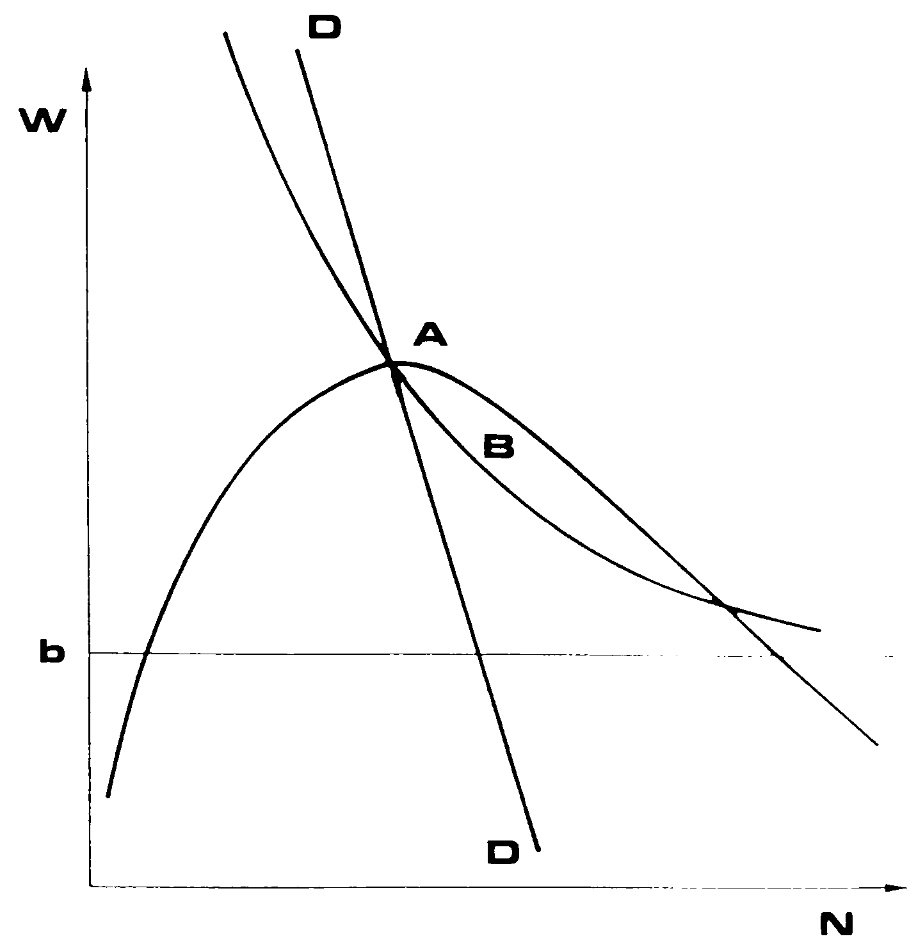
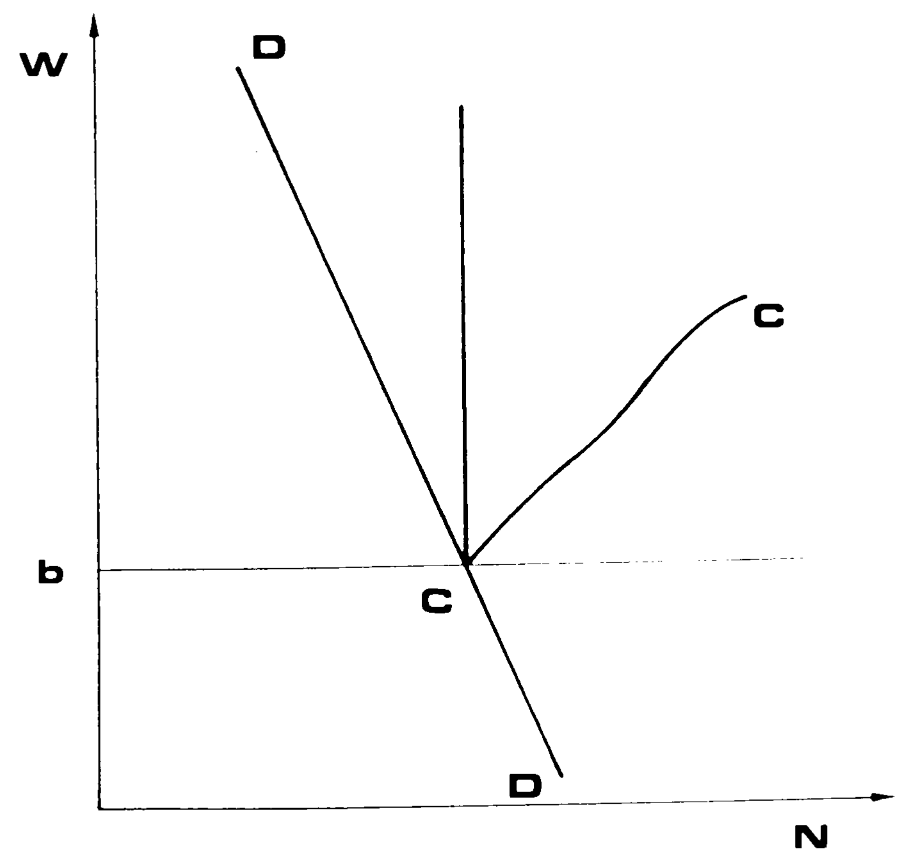


Figure 1.5.1 The contract curve



1.5 Efficient bargaining

From union monopoly to bilateral monopoly

This type of model can be traced back to Leontief (1946), however, it has taken centre stage following McDonald and Solow (1981). Its name is attributable to the fact that it is an attempt to overcome the built-in inefficiency of the right-to-manage framework.

The efficient bargaining model exploits the fact that both the firm and the union can gain in co-operating with each other. A bargain would be efficient if the gains to the union were maximised subject to a given level of gain for the firm, or vice versa. The "contract curve", or the set of efficient wage-employment combinations, are thus given by

$$\max_{W,N} \; U(W,N) - \lambda \, [\, \Pi(W, N) - \Pi_o] \qquad (1.5.1)$$

where U and Π are given by (1.4.3) and (1.4.5) respectively.
The first order condition gives

$$-U_n/U_w = (R'(N)-W)/N \qquad (1.5.2)$$

i.e., the marginal rate of substitution, MRS, between wages and employment for the union should equal that for the firm. We can re-write the above equation as:

$$R'(N) = W - \sigma N \quad \text{where } \sigma = U_n/U_w \qquad (1.5.3)$$

The "contract curve" is the locus of points in the (W,N) space satisfying (1.5.3). We note that the difference between the efficient contract and the labour demand curve is simply the existence of σ.

Using the expression for U(W,N) from (1.4.3), we can re-write (1.5.2):

$$R'(N)-W = -\ (U(W)-U(b))\ /\ U'(W) \tag{1.5.4}$$

So at $W=b$, the contract curve intersects the labour demand curve and since from (1.5.3) the marginal revenue product of labour is less than the negotiated wage for $W>b$, the contract curve lies to the right of the labour demand schedule.

If the union is risk neutral then its utility will be a linear function, from (1.5.4) we have:

$$R'(N) = b \tag{1.5.5}$$

so the contract curve is a vertical straight line. However, if the union is risk averse, i.e., $U''(W)<0$, then:

$$\frac{dW}{dN} = \frac{R''(N)U'(W)}{[W-R'(N)]U''(W)} > 0 \tag{1.5.6}$$

the contract curve, CC, slopes upwards in the wage-employment space as shown in Figure 1.5.1. As wages increase, the opportunity cost to each union worker of not being employed increases, and so the union pushes for higher employment to insure its members against the risk of becoming unemployed.

An increase in union bargaining power in this model pushes the solution further up the contract curve leading to both higher wages and employment. This is in stark contrast to the right-to-manage model and its policy implications are profound. If this result is true, then the government's policies designed to curb trade union power also lead to lower employment! An increase in alternative wages, b, shifts the contract curve up and to the left leading to higher wages and lower employment. McDonald and Solow (1981) also show that the impact of increasing the output price in this model is the same as that in the right-to-manage model; namely, if the wage elasticity of demand is independent of the output price, changes in the latter will have no influence on the real wage.

For the bargain to be efficient we must have bargaining over both wages and employment. Bargaining over employment has to be contingent on profits and any factors affecting profits such as the eventual degree of demand in the economy. It is generally rare to observe such contingent contracts, although measures such as profit sharing can be regarded as a contingent contract. Also, firms may have better information regarding product market performance than the union and they may use this information to cheat on the contract, in other words, contingent contracts are "incentive incompatible". From an empirical point of view, there is no reason to believe that if a wage-employment outcome is not on the labour demand curve then it has to be on the contract curve, one is not "nested" within the other. There may be a whole range of other factors, affecting employment and wages, over which the bargain can take place such as working practices, demarcation, hours of work, manning levels, etc.

Manning (1987) has an interesting model incorporating features of both the right-to-manage model and the efficient bargaining model. There is a sequence of two Nash bargains, the first bargain is over real wages, the second over the level of employment. Due to uncertainty regarding future demand and difficulties associated with enforcing contingent contracts, bargaining over employment takes place only once every few years while there are annual bargains over wages. In the second stage the objective function is:

$$\max_{N} \{N[U(W)-U(b)]\}^{q} \{\Pi-\Pi_{o}\}^{1-q} \tag{1.5.7}$$

where q is the bargaining strength of the union in negotiating the level of employment. The first stage bargain optimizes over wages:

$$\max_{W} \{N[U(W)-U(b)]\}^{p} \{\Pi-\Pi_{o}\}^{1-p} \tag{1.5.8}$$

where p represents the bargaining power of the union in setting the real wage.

If p=q, then we have the efficient bargaining model, if q=0, then the wage-employment outcome is that achieved by the right-to-manage model. If q=0 and p=1, then we have the union monopoly model as the special case of the right-to-manage model. The model shows explicitly that the efficient bargaining model (p=q) and the right-to-manage model (q=0) are non-nested. However, discovering the values of p and q empirically is difficult since union power is unobservable.

There have been a number of empirical studies testing the right-to-manage model against the efficient bargaining model. These have mainly focused on one testable restriction of the right-to-manage model. This restriction indicates that variables such as fall-back wages should affect employment only through their effect on the wage rate. Accordingly, in the right-to-manage model, fall-back wages should be insignificant when entered in a regression of employment on the wage rate and other parameters of the model. This restriction need not hold if the efficient bargaining model prevails. The empirical studies have focused on heavily unionised sectors of the economy where the single union/single employer assumption of the theory can be approximately upheld.

Brown and Ashenfelter (1986) test two separate versions of the efficient bargaining model using US newspaper industry data. The "strong efficiency" model assumes that the unions are rent maximisers. In this case the contract curve is vertical and employment is determined by the fall-back wage, b. This version is rejected by the data. In the second version, "weak efficiency", employment is assumed to be influenced by both the fall-back wage and the negotiated wage. This, they argue, is consistent with the wage-employment outcome being on the contract curve. Brown and Ashenfelter's methodology is a very indirect test of the model and, unfortunately, their findings are not robust. For instance, the sign of the fall-back wage is wrong in some specifications so that increases in the fall-back wage lead to higher employment. MaCurdy and Pencavel (1986) provide some evidence against the right-to-manage model. They assume that the labour demand curve is a restricted version of the contract curve; however, as we pointed out above this 'nesting' is not strictly correct. It is inconsistent to assume that the union cares about employment by being on the labour demand curve when it is originally assumed that the union does not bargain over employment.

Bean and Turnbull (1987) and Carruth, Findlay and Oswald (1986) provide evidence for the United Kingdom. The latter study tries to combine the right-to-manage and the efficient bargaining models by assuming flat union indifference curves. However, they find that unemployment benefits have a significant effect both on wages and employment. Bean and Turnbull (1987) also find that variables representing the fall-back wage significantly influence the level of employment. In this study wages are instrumented in the employment equation and, since wages are assumed to be endogenous in the efficient bargaining framework, the instruments consist of lagged wages. However, if there are costs of adjustment or lagged wages appear in the union utility function, lagged wages will be inadequate instruments.

Alogoskoufis and Manning (1987) attempt to test the right-to-manage model directly against the efficient bargaining model not by nesting them in each other but by nesting both of them in a more general framework. They use aggregate data and find that both models are rejected in favour of the more general sequential bargaining framework. However, it is doubtful that any single union/single firm model can be directly tested using aggregate data.

1.6 Efficiency wages

Higher wages mean better workers

In the efficiency wages framework, workers are heterogeneous. Their ability and productivity vary considerably. Furthermore, the wages they receive affect the effort they put into their work and thus their productivity. The level of effort exerted by each worker is difficult to observe and monitor, so if the firm were to cut its wages, the more productive workers would decide to leave and the firm's productivity would fall and hence its costs would rise.

Consider the efficiency wage model due to Solow (1979). The firm has a production function of the form:

$$Y = sF(e(W, b)N) \qquad F'>0,\ F''<0 \qquad (1.6.1)$$

where s reflects shifts in technology, e represents effort and is an increasing function of the real wage and a decreasing function of the alternative wage, b. Note that output depends on the product of effort and employment. The firm maximises profits:

$$\Pi = spF(e(W, b)N) - WN \qquad (1.6.2)$$

the first order conditions are:

$$\frac{We'(W, b)}{e(W, b)} = 1 \tag{1.6.3}$$

and

$$e(W, b)sF'(e(W,b)L) = W \tag{1.6.4}$$

the wage is determined from (1.6.3) which states that the elasticity of effort with respect to wages is unity. The wage is independent of s and will depend upon b and any other factors affecting effort. Employment is determined from (1.6.4) which states that the marginal product of an additional worker must equal the wage rate. This level of employment could deviate from the competitive level and so there may be those who wish to work but cannot find a job. Thus the existence of involuntary unemployment can be generated with efficiency wage models. Shapiro and Stiglitz (1984) present an efficiency wage model by assuming that the employer cannot always observe the workers who 'shirk'. They show that the real wage would then explicitly depend on the probability of becoming unemployed as well as the alternative wage and other factors affecting workers' effort. Akerlof (1984) and Akerlof and Yellen (1987) have explored sociological models in which a reduction in wages is considered unfair by workers, leading them to reduce their effort.

From an empirical point of view, it is very difficult to test the efficiency wage model directly because effort is unobservable. Most empirical findings in favour of efficiency wages conclude that their evidence is inconsistent with other models and hence consistent with efficiency wages. It is difficult to come up with a set of testable hypotheses which confirm or negate the efficiency wages model.

Nickell and Wadhwani (1987), for instance, test for the elasticity of alternative wages in an employment equation using data on 200 firms over a ten year period. We know from the discussion in Section 1.5

that the efficient bargaining model predicts that alternative wages must have a negative impact on employment and a positive influence on wages. Also, from our discussion of Section 1.4 we know that alternative wages should bear no direct influence on employment. Nickell and Wadhwani find that alternative wages have a positive impact on employment. Given that the sign can be either positive or negative in the efficiency wages model, they conclude that their finding is inconsistent with both the right-to-manage and efficient bargaining models and consistent with efficiency wages. Although this work is a valuable contribution to the debate it suffers from a number of problems. The fall-back wage is the industry average wage; mobility of labour across industries would make this an insufficient measure of alternative opportunities. Nickell and Wadhwani do not have a direct measure of wages, their variable is the firm's aggregate remuneration. This is a poor measure of workers' pay since it includes pay to all staff including managers.

1.7 Theoretical inefficiencies in the bargaining theory

Hidden assumptions

So far we have made a number of assumptions that need looking at more carefully. To obtain (1.4.3) we assumed that membership of a trade union is constant; the above models give no indication of the impact of trade union membership on the bargaining outcome and hence on wage determination. It is not, for instance, inconceivable that trade union membership might affect the bargaining power of the union.

To explore the impact of changing membership on the bargaining outcome scholars have introduced discrete time optimization. We can, for instance, assume that there are two periods and that union membership in the second period, M_2, is given in terms of the first period membership, M_1:

$$M_2 = M_1 + \delta(N_1-M_1) \qquad N_1 \leqslant M_1,\ 0<\delta<1 \qquad (1.7.1)$$

where N_1 is employment in the first period. Now we can postulate a union utility function such as that in (1.4.1) and the optimisation in any of the above models would be over two periods. For instance, under the union monopoly model Carruth and Oswald (1985) show that the first period wage would be lower than that derived from the one period model with exogenous membership. The reason for this is that if membership appears in the union's objective function then the union would desire a higher level of employment this period so that it would gain more members in the next period. However, this assumes that the union does not care about the utility of those first period members who leave the union in the second period, M_1-M_2. Carruth and Oswald show that if the union cares about these members then the wage-employment outcome in each period would be the same as it would be with membership exogenous. Besides, the two-period model implies that an increase in membership entails lower wages; this must be counter factual.

There is also another aspect in the two-period model which needs to be considered. Does employment in one period depend on the probability of having been employed in the previous period? In particular, what happens if the firm lays off workers in reverse order of seniority. An interesting situation arises if the union maximises the utility of the member with median seniority. As long as the level of employment is sufficiently large for the median worker to stay in employment then the union will be indifferent to the level of employment. The union utility function will then be horizontal for employment levels greater than that which just keeps the median worker employed. The 'lay-off by seniority' model due to Oswald (1987) removes the distinction between the right-to-manage model and the efficient bargaining model by assuming horizontal union indifference curves. However, this does not solve the membership problem. If there is lay-off by seniority, an unemployed worker no longer has an incentive to remain in the union and quits. Membership of the union declines and it pays the new median worker to bid up wages and reduce the membership even further.

Booth and Ulph (1988) illustrate that if the union is larger than a critical size then the introduction of membership will not affect the outcome of standard bargaining theories described above. If we assume that union members often possess skills which are hard to come by in the competitive sector, then this condition could explain why unions are so prevalent in some sectors of the economy such as manufacturing and less important in others, for example services.

Membership models are closely related to the insider-outsider models in which the insiders face a lower probability of becoming unemployed and thus have an incentive to raise wages leading to persistence of unemployment or 'hysteresis'.

Another problem with our bargaining models is that we have so far assumed that the bargain is between one firm and one union. Although this may be a satisfactory assumption in some sectors of the economy, it is not universally true. One can imagine all types of game theoretic considerations affecting the bargaining outcome if there is more than one union or one firm involved in negotiations.

In all the bargaining models above we have assumed that the solution is characterised by the Nash solution. If so it is difficult to see why strikes occur. Besides there is no mechanism to incorporate the sequences of threats and counter threats frequently observed in negotiations.

The fact that the wage outcome in the above bargaining models can be independent of changes in the output price of the firm is an unsatisfactory feature since, by assumption, the firm has to have a degree of monopoly in the product market. Imperfections in the product market must play some role in explaining the willingness of the firm to reach a settlement and so by implication it must affect the union power in a bargain and hence the negotiated wage.

1.8 Towards an empirical framework

The above discussion leads us to believe that testing between various theories of wage determination is a difficult and hazardous task. There are many complicating factors, the hypotheses cannot be "nested" in each other and instruments for identifying the contract curve are difficult to determine. Besides, in efficiency wage models the fall-back wages may have a role in the employment equation. Therefore, the significance of fall-back wages in the employment equation, which has been used to discriminate between the right-to-manage model and the efficient bargaining model, may not necessarily be taken as evidence in favour of efficient bargaining.

However, in this thesis we are not concerned with testing the alternative theories of wage determination. Our aim has been to survey the theories of wage determination to identify the factors which influence the level of real wages.

So far in this chapter we have shown that since the late 1970s there has been an upsurge in theoretical work in the area of wage determination. Although there may not be a consensus on a universal framework, and no doubt each model has its merits and shortcomings, some of which were illustrated above, the models have broadly similar implications with regard to the determinants of wages. Nickell (1982) derives a wage equation which is compatible with both the right-to-manage and the efficient bargaining model with identical comparative statics results. It can be argued that the above models justify the inclusion of a host of variables such as unemployment, alternative wages, trade union power, mismatch, profits, productivity and tax wedges in a wage equation.

Although there may be a consensus on the theoretical foundation of the determinants of wages, no such consensus exists when it comes to the empirical evidence. Given the high levels of wage inflation in the UK economy the exact determinants of wages are of crucial importance from a policy point of view. In the next chapter we turn to an empirical investigation of wage determination using UK earnings data. In particular, we make an attempt to separate the issues about the behaviour of real wages in the long-run from questions about the dynamics.

In our empirical work we may not always be able to uphold the standards of theoretical purity. However, in the words of Willis (1986), this is explained by "the pragmatic trade-offs any applied economist must make between theoretical rigor, analytical tractability, limitations of the data and the econometric methodology".

Chapter Two

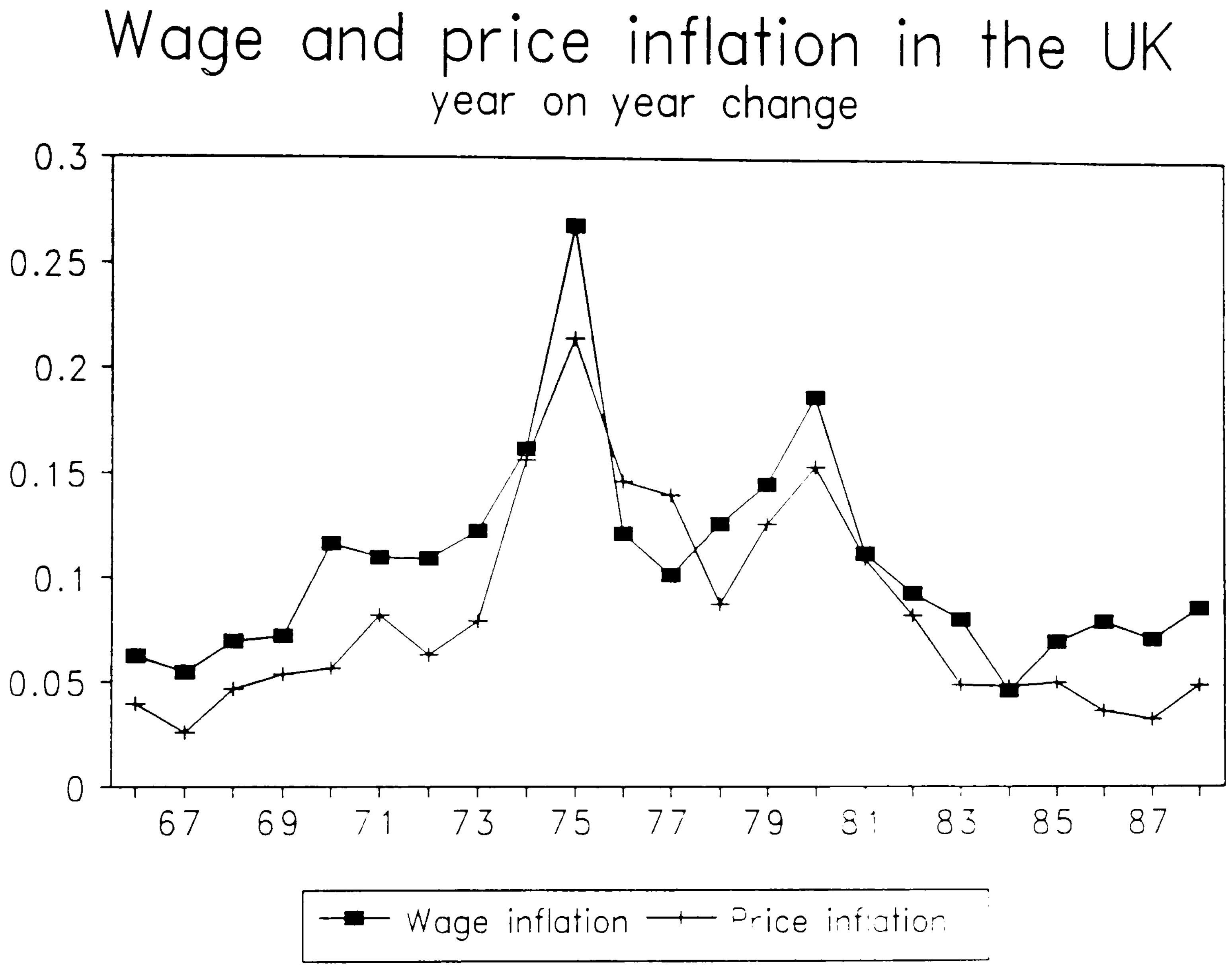
Wage Determination in the United Kingdom: Are Wages Forward Looking?

2.1 Introduction

Wage inflation has been a recurring problem in the UK economy since the mid-1960s. Although considerable work has been done in this area and, as we illustrated in Chapter One, the theory of wage determination has been developed extensively, there is no empirical consensus about the key determinants of wage inflation. The resurgence of empirical work in this area can be attributed to attempts by scholars to explain the continued existence of high wage inflation in spite of unprecedented levels of unemployment throughout the 1980s. Figure 2.1.1 shows a notable feature of 1980s wage inflation in the UK: although wages and prices followed a similar path during the 1960s and 1970s, there is a distinct divergence of wage and price inflation during the 1980s. Wages continued to rise while price inflation was falling and unemployment rising.

There have been many valuable and even a few controversial studies in this area. The most widely quoted works are Layard and Nickell (1986) and Nickell (1987). Layard and Nickell (1986) adopt an imperfectly competitive framework. They estimate a system consisting of a wage equation, a price equation and a labour demand equation. There are two major findings in this work, firstly, they discover that the long-term unemployed exert no downward pressure on wages. Secondly, they demonstrate that a good proportion of the rise in unemployment can be attributed to demand factors rather than to pressures on pay. Layard and Nickell solve their estimated system to obtain the 'natural rate of unemployment' or NAIRU. They argue that this rate rose substantially during the early 1980s.

Figure 2.1.1


Wage and price inflation in the UK
year on year change
0.3
0.25
0.2
0.15
0.1
0.05
0
67
69
71
73
75
77
79
81
83
85
87
Wage inflation
Price inflation

Blanchard and Summers (1987) argue that it is not the level of unemployment that matters but changes in the level of unemployment. This idea is meant to capture the persistence or 'hysteresis' in unemployment. Bover, Muellbauer, and Murphy (1988) postulate that house prices have fuelled wage inflation. They put forward a number of reasons: house prices contribute to the cost of living, yet they are not fully reflected in the retail price index; labour mobility to the growth areas such as the South East is hindered by the high cost of housing; furthermore, rising house prices increase inflationary expectations and encourage the unions to insist on higher wages. It is interesting to note that the real value of houses, especially in the South East, has been falling since 1989, yet there is no sign of falling wage inflation.

Carruth and Oswald (1987), Blanchflower, Garrett and Oswald (1988) suggest that it is real profits per head which should enter the wage equation. In particular, Carruth and Oswald (1989) strongly argue that profits are an indication of industrial prosperity and hence a good indication of the firm's ability to pay. In this work Carruth and Oswald also point out that other variables such as financial performance and productivity may also be regarded as indicative of the firm's ability to pay.

In a recent 'Economic Progress Report' (1989), the Treasury argues that in the 1980s productivity 'has grown faster in the UK than in any of the Group of Seven leading industrial economies except Japan', and that manufacturing productivity growth 'has been faster in the UK than all the other G7 countries'. The Treasury's figures are provided in Table 2.1.1 below:

Table 2.1.1

Output per person employed

(Average annual % change)

	1960-70	1970-80	1980-88
Whole economy			
UK	2.4	1.3	2.5
US	2.0	0.4	1.2
Japan	8.9	3.8	2.9
Germany	4.4	2.8	1.8
France	4.6	2.8	2.0
Italy	6.3	2.6	2.0
Canada	2.4	1.5	1.4
G7 avg.	3.5	1.7	1.8
Manufacturing			
UK	3.0	1.6	5.2
US	3.5	3.0	4.0
Japan	8.8	5.3	3.1
Germany	4.1	2.9	2.2
France	5.4	3.2	3.1
Italy	5.4	3.0	3.5
Canada	3.4	3.0	3.6
G7 avg.	4.5	3.3	3.6

Source: Economic Progress Report, April 1989

Table 2.1.2

UK productivity growth

	Comparison of booms		Comparisons of cycles	
	Average of booms, 1960-	1986-88 boom	Average of cycles, 1960-	1979-88
Whole economy	3.9	1.5	2.2	1.8
Manufacturing	6.0	5.2	2.7	4.0

Source: Davies (1989)

High productivity growth may well explain the divergence of wage inflation and price inflation in the UK during the 1980s. However, the Treasury figures are decade averages rather than averages of economic cycles. The latter are provided in Table 2.1.2. These figures cast doubt on the 'productivity miracle' of the 1980s. This table presents productivity growth for periods of economic boom as well as economic cycles since 1960. Table 2.1.2 indicates that although there was an improvement in manufacturing productivity between 1979 and 1988, there is little evidence of a supply side miracle especially when comparing periods of economic boom or the productivity of the whole economy.

The lack of empirical consensus applies to both the long-run determinants of wages and the dynamics of wage inflation. One key aspect of the latter is a general debate about whether agents look forward or use backward looking rules of thumb. This debate can be traced to Lucas and Rapping (1970) and Lucas (1973) but can be re-examined in the light of the new techniques put forward in Hendry

(1988).

In this chapter we present the results of a study of UK earnings behaviour over the period 1967 to 1987. We estimate our earnings equations using a two-stage procedure suggested by Engle and Granger (1987). This allows us to separate clearly issues about the behaviour of real wages in the long-run from questions about dynamics. In examining long-run behaviour we focus on the relative importance of short and long-term unemployment, the role of various tax rates, real import prices, productivity, profits, house prices, the replacement ratio and the degree of industrial mis-match in the economy. Our principle concern with dynamics is whether wage setters attempt to anticipate future movements in prices.

Section 2.2 briefly sets out a long-run model of wage determination based on the bargaining framework of Section 1.4 in Chapter One. Section 2.3 uses cointegration techniques to estimate this long-run relationship, using both OLS and procedures suggested by Johansen. Section 2.4 briefly outlines some of the dynamic consequences of the existence of long-term wage contracts for nominal wage setting. Two models are proposed; the first where agents form rational predictions about future price movements, and a second where agents use instead simple rules of thumb based on past price movements. In Section 2.5 these two dynamic models, based on the same long-run equation, are compared using some of the ideas recently put forward in Hendry (1988). The conclusion to this chapter summarises the main results.

2.2 A bargaining model of wage determination

In spite of the decline of the trade union membership during the last decade, shown in Table 1.4.1, collective bargaining is still widely prevalent. It therefore seems reasonable that any realistic model of wage and employment determination must incorporate this aspect of the labour market by adopting one of the bargaining models set out in Chapter One.

Here we derive a wage equation based on the 'right-to-manage' model in which the firm is on the labour demand schedule[1]. There is considerable anecdotal and empirical support for the 'right-to-manage' model especially since one does observe firms adjusting employment continuously without re-negotiating contracts.

As we pointed out in Chapter One, although the competing theories of wage determination have different implications when it comes to the employment equation, they postulate very similar wage equations. In particular, Nickell (1982) has demonstrated that a wage equation derived from the right-to-manage model has identical comparative statics to one derived from an efficient bargaining model. Hence, they are observationally equivalent.

Here we consider the right-to-manage model of Section 1.4 and closely follow Nickell's (1984) exposition of it.

Suppose W, the wage, is the outcome of:

$$\max_W [U(\Pi(W,N^*(W))) - U(\bar{\Pi})]^{\beta}[(U(W,N^*(W))-\bar{U})] \qquad (2.2.1)$$

where $U(\bar{\Pi})$ and $\bar{U}$ are fall back levels of the utility functions for the firm and the union respectively, W is the nominal wage and N^* is firms' demand for labour.

We may write the firm's profit function as:

$$\Pi(W,N) = (P_f/P_c)Y(N,K) - (W/P_c)\ (1+t_1)N \qquad (2.2.2)$$

where Y is the production function, N is employment, P_f the price of output, P_c the price of consumption goods and t_1 is the employer's 'tax wedge', i.e. non-wage labour costs such as national insurance contributions. Since we are interested in the long-run determinants of wages we ignore any expectations in the variables.

Let us specify the working union members' utility function:

$$V = V((W/P_c)(1-t_2) - \bar{W}) \qquad (2.2.3)$$

where $\bar{W}$ are subsistence real wages and t_2 the direct tax wedge, i.e. income taxes.

The utility of those union members who are unemployed can be represented as:

$$V = qV\ ((B/P_c)-W) + (1-q)V(W^*/P_c)(1-t_2)-\bar{W}) \qquad (2.2.4)$$

where q is the probability of being unemployed, B represents benefits and W^* alternative wages. Nickell (1984) shows that the outcome of the Nash bargain is the following aggregate wage equation:

$$\log(W/P_c) = b_0 + b_1 \ln (W^*/P_c) + b_2 \ln (B/P_c) + b_3\ q + b_4 \ln \bar{W}$$

$$+b_5\ t_1 + b_6\ t_2 + b_7 \ln (P_f/P_c) + b_8 \ln \bar{\Pi} + b_9 \ln K/N \quad (2.2.5)$$

Now we can substitute out W^* and $\bar{W}$ in the long run by assuming that they can be approximated by the actual real wage, also we substitute out K/N in terms of Y/NH from the production Y = Y(NH,K) where Y/NH represents output per man hour. Hence we have:

$$b_1 \ln(W^*/P_c) + b_4 \ln \overline{W} + b_9 \ln K/N = \gamma_0 + \gamma_1 \ln(Y/NH) + \gamma_2 \ln(W/P_c) \quad (2.2.6)$$

We postulate that the probability of being unemployed depends on the short-term unemployment rate and the degree of mismatch in the economy:

$$q = \beta_0 + \beta_1 \ln US + \beta_2 \ln MM \quad (2.2.7)$$

where US represents short-term unemployment and MM mismatch.

We assume that fall back profits are constant to obtain the following final equation:

$$\ln (W/P_c) = a_0 + a_1 \ln US + a_2 \ln (B/P_c) + a_3 t_1 + a_4 t_2 + a_5 t_3 + a_6 \ln (Y/NH) + a_7 \ln MM + a_8 \ln (P_m/P_c) \quad (2.2.8)$$

where t_3 is the indirect tax wedge, and P_m/P_c are real import prices. Nickell (1984) demonstrates that:

$a_1<0$, $a_2>0$, $a_3\leqslant0$, $a_4>0$, $a_5<0$, $a_6>0$, $a_7>0$ and $a_8\leqslant0$.

The above equation can be written in the following log linear form:

$$w-p_c = a_0 + a_1 us + a_2 (b-p_c) + a_3 t_1 + a_4 t_2 + a_5 t_3 + a_6 (y-n-h) + a_7 mm + a_8 (p_m-p_c) \quad (2.2.9)$$

where all lower case letters apart from the tax wedges are in logs. (2.2.9) will form the long-run equation to be estimated by cointegration techniques.

A number of points may be made about this equation in relation to the literature. We use the short-term unemployment rate in preference to the total unemployment rate, because this appears to be a better proxy for the probability of becoming unemployed. The role, if any, of the long-term unemployed in influencing wages has been examined by a number of authors; e.g. Layard and Nickell (1986) and Nickell and Wadhwani (1989). Although their overall conclusion supports our choice of short-term unemployment, this is an issue we will examine empirically in the next section.

The literature is fairly divided on the use of productivity in wage equations. Although Hall (1988) obtains cointegrating vectors using productivity, Layard and Nickell (1986) tend to use the capital labour ratio and Carruth and Oswald (1989) focuses on profits. In practice these three measures are closely related, but in the next section we examine their relevance as long-run determinants of earnings.

2.3 Cointegration theory

Over the last few years the notion of cointegration has become increasingly influential. The techniques associated with cointegration, such as the Granger-Engle two step procedure, are now widely used in econometric modelling. The long-run properties of many large-scale macro-econometric models such as those of the National Institute, the London Business School, the Treasury and the Bank of England are increasingly based on estimating cointegrating vectors.

The theory of cointegration is by no means devoid of problems: for instance, the small sample bias and the lack of robust testing techniques have been well documented in Banerjee et al (1986) and

Hendry and Mizon (1989) among others. However, interest in the subject has stimulated a great deal of research into the theory and application of this technique and scholars have had some success in solving some of the associated problems. Interest in cointegration has been such that special a issue of the Oxford Bulletin of Economics and Statistics (1986) and a special issue of the Journal of Economic Dynamics and Control (1988) were entirely devoted to cointegration. Hendry (1986) and Hall and Henry (1988) provide surveys of the cointegration literature.

The basic idea of a set of cointegrating variables is that if in the long-run two or more macroeconomic variables move closely together, even though they may drift apart in the short-run, we may regard these series as defining a long-run equilibrium relationship and refer to them as a cointegrating vector. An Ordinary Least Squares (OLS) regression containing all the variables of a cointegrating vector will have a stationary error term. This stationarity is central to cointegration theory.

Let us denote a stationary series as I(0). If a series needs differencing d times to become I(0), then it is called integrated of order d, denoted $X_t \sim I(d)$. Granger (1981) proves that if we take a linear combination of two series, each integrated at a different level, then the resulting series will be integrated at the highest of the two orders of integration. This implies that if we have two variables which are integrated at different orders of integration then these two series <u>cannot</u> possibly form a long-run cointegrating relationship. However, a long-run relationship is possible with more than three series of different orders of integration. For example suppose $Y \sim I(1)$, $X \sim I(2)$ and $W \sim I(2)$ then if:

$$V_t = a\ X_t + cW_t \sim I(2-1)=I(1)$$

$$Z_t = e\ V_t + fY_t \sim I(1-1)=I(0)$$

the vector Z_t is thus stationary.

Formally, cointegration may be defined as follows: the components of the vector X_t are said to be cointegrate if there exists a vector β such that:

$$Z_t = \beta' X_t \sim I(0) \tag{2.3.1}$$

The vector β is then the cointegrating vector.

Stock (1984) demonstrates that $\hat{\beta}$, the OLS estimates of the cointegrating vector, are consistent estimates of β. Stock also shows that the OLS estimates in this non-stationary case converge on their true parameter values much faster that in the stationary case. This property is referred to as "super consistency".

The proof of the consistency of the OLS estimator does not require the assumption that the regressors should be uncorrelated with the error term. In fact any of the variables in a cointegrating vector may be used as the dependent variable in the regression with the estimates remaining consistent. This means that problems do not arise when we have endogenous independent variables or when these variables are measured with error.

Scholars have proposed a number of procedures to test for the cointegration of a set of variables. One may simply inspect the correlogram of the error process: if the correlogram rapidly converges to zero and then remains close to it, the error process may be considered stationary. To bring more rigor to bear upon the subject, Engle and Granger (1987) propose a range of possible tests based on the unit root literature such as the Dickey-Fuller (DF) and augmented Dickey-Fuller (AUDF) tests. Sargan and Bhargava (1983) propose the use of the Durbin-Watson statistics and provide critical values for this test. Recently, Johansen (1988, 1989) has put forward a likelihood ratio test.

An important result using cointegration is the Granger (1983) representation theorem. This theorem states that if a set of variables are cointegrated then there exists a valid error correction representation (ECM) of the data:

$$A(L)\ (1-L)X_t = -\gamma' Z_{t-1} + d(L)\epsilon_t \tag{2.3.2}$$

where X_t is a Nx1 vector such that $X_t \sim I(1)$, $Z_t = \beta' X_t$, L is the lag operator, A(L) and d(L) are finite order polynomials and ϵ_t is a vector of error terms. The above equation contains only stationary variables so the usual stationary regression theory applies.

Engle and Granger (1987) show that once OLS has been used to estimate the cointegrating vector (2.3.1), then the other parameters of the ECM in (2.3.2) may be consistently estimated by imposing the first-stage estimates of the cointegrating vector on the second-stage ECM. This is done by including the residuals from the first stage cointegrating regression, (2.3.1), into (2.3.2) instead of the vector Z_{t-1}. This technique is known as the Granger-Engle two-step procedure.

The two-step procedure allows the use of super convergence properties of the first-stage estimates. Besides, if the variables in the first stage properly cointegrate, then the full ECM will satisfy all the usual 'classical' assumptions of conventional econometrics.

Some authors have raised doubts about the robustness of the cointegration technique. Banerjee et al (1986) argue that there may be considerable small sample bias in the estimated parameters of cointegrating vectors. Hendry and Mizon (1989) illustrate that the conventional DF and AUDF tests suffer from parameter instability; this together with the absence of well defined limiting distributions for these cast doubt on the robustness of these tests. Furthermore, it is not inconceivable that any given set of macroeconomic variables may contain more than one long-run relationship; the procedures which we have discussed so far do not provide us with the means to identify all these relationships.

Johansen (1988) offers an estimation methodology which goes some way towards providing a remedy for these problems. He derives maximum likelihood estimators for <u>all</u> the cointegrating vectors in a given set of variables and a likelihood ratio test for the hypothesis that there is a certain maximum number of cointegrating vectors.

2.4 The Johansen Procedure

Johansen (1988, 1989) and Johansen and Juselius (1990) consider the following general vector autoregressive representation (VAR):

$$X_t = \Pi_1 X_{t-1} + \ldots + \Pi_k X_{t-k} + \mu + e_t \quad (t=1,\ldots,T) \qquad (2.4.1)$$

where X_t is a vector of p variables, $e_1,\ldots,e_t$ are $IIN_p(o,\Lambda)$, $X_{-k+1},\ldots,X_o$ are fixed and μ is an intercept vector.

Economic time series are often non-stationary and VAR systems such as the one above are written in first difference form:

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \Gamma_{k-1} \Delta X_{t-k+1} + \Pi X_{t-k} + \mu + e_t \qquad (2.4.2$$

where

$$\Gamma_i = -(I-\Pi_1-\ldots-\Pi_i) \qquad (i=1,\ldots,k-1) \tag{2.4.3}$$

and

$$\Pi = -(I-\Pi_1-\ldots-\Pi_k). \tag{2.4.4}$$

This model is now expressed in the conventional first difference VAR form. The only level term is ΠX_{t-k}, thus, Π is the cointegrating matrix containing information about the long-run relationships between the variables in the data vector.

There are three possibilities:

(i) if the matrix Π has rank zero, then all the variables in X_t are integrated of order one or higher and the VAR has no long-run properties.

(ii) Π has rank p, i.e., it is full rank. In this case all the variables in X_t are stationary.

(iii) an interesting case arises when Π has rank r, $0<r<p$. In this case we can decompose Π into two distinct (pxr) matrices α and β such that $\Pi=\alpha\beta'$.

In the third case the parameters of the cointegrating vectors are contained in the β matrix. Therefore, $\beta' X_t$ is stationary even though X_t itself is non-stationary. In this case (2.4.2) is simply a conventional error correction model.

Johansen (1988) provides a likelihood ratio test for the maximum number of cointegrating vectors in the data set as well as maximum likelihood estimators for all the cointegrating vectors.

To implement Johansen's procedure one begins by regressing ΔX_t on lagged differences of ΔX_t and defining a set of residuals R_{ot}. We then regressing X_{t-k} on the lagged differences and define another set of residuals R_{kt}. The likelihood function is then

$$L(\alpha,\beta,\Lambda) = |\Lambda|^{-T/2}\mathrm{EXP}\{-1/2 \sum_{t=1}^{T} (R_{0t} + \alpha\beta' R_{kt})'\Lambda^{-1}(R_{0t} + \alpha\beta' R_{kt})\}. \tag{2.4.5}$$

Let

$$S_{ij} = 1/T\ (\Sigma\ R_{it}\ R'_{jt}) \qquad i,j = o,k. \tag{2.4.6}$$

Johansen (1988) proves the following theorem:

"Under the hypothesis $H=\alpha\beta'$, the maximum likelihood estimator of β is found by the following procedure:

First solve the equation

$$|\lambda S_{kk} - S_{ko}S_{oo}^{-1}S_{ok}| = 0 \tag{2.4.7}$$

giving the eigenvalues $\hat{\lambda}_1 > \ldots > \hat{\lambda}_p$ and eigenvectors $\hat{V}=(\hat{v}_1,\ldots,\hat{v}_p)$ normalized such that $\hat{V}' S_{kk}\hat{V}=I$.

The choice of $\hat{\beta}$ is now

$$\hat{\beta}=(\hat{v}_1,\ldots,\hat{v}_r), \tag{2.4.8}$$

which gives

$$L_{max} = |S_{oo}|^{-T/2} \prod_{i=1}^{r}(1-\hat{\lambda}_i). \tag{2.4.9}$$

The estimates of the other parameters are found by inserting β into the above equations. The likelihood ratio test statistics for the hypothesis that there are at most r cointegrating vectors is:

$$-2ln(Q)= -T \sum_{i=r+1}^{p} ln\ (1-\hat{\lambda}_i)." \tag{2.4.10}$$

Johansen then proceeds to explore the properties of the maximum likelihood estimates. In particular, he demonstrates that the likelihood ratio test, that there are at most r cointegrating vectors in the data set, has an asymptotic distribution which is the only function of p-r and free of any unwanted parameters. Johansen and Juselius (1990) also calculate a set of critical values for this test.

Thus the Johansen procedure may be summarised as follows: first we regress ΔX_t and X_{t-k} on the lagged differences of X_t. The residuals from these regressions form R_o and R_k respectively. These two sets of residuals are then used to form the matrices S_{oo}, S_{ok}, S_{kk} and S_{ko} defined in (2.4.6). We then calculate the eigenvalues associated with (2.4.7) in order to obtain, from (2.4.10), the likelihood ratio test statistics for the hypothesis that there are at most r cointegrating vectors in our data set. The critical values for this test can be found in Johansen and Juselius (1990). Finally, the eigenvectors associated with each eigenvalue provide us with the cointegrating vectors.

2.5 Cointegration results

Conventional econometric theory is based on the assumption that variables are stationary. In practice a large number of economic time series are not stationary because, for example, they embody secular trends. Recent developments in cointegration theory (such as Hendry (1986)) have shown how this apparent contradiction can be reconciled. Although individual variables may not on their own be stationary, they may form a 'cointegrating vector' which involves a stationary error process.

We can explore the order of integration of the variables which enter equation (2.8) using the Dickey-Fuller, Augmented Dickey-Fuller and Sargan Bhargava tests given in Table 2.5.1.[2]

The null hypothesis that the series are stationary can be rejected from the above DF, ADF and DW statistics. However, all the first differences have negative and significant values for DF and ADF tests.[3] Thus, we can conclude that the series are integrated of order 1, I(1), and we know from Granger (1981) that it is possible for a set of I(1) variables to form a cointegrating set.

Table 2.5.1. Order of integration

Variable	DF	ADF	DW^3
$w-p_c$	-1.3	-0.4	0.01
$\Delta(w-p_c)$	-10.3	-4.5	2.13
us	-1.0	-1.6	0.03
Δus	-6.3	-3.7	1.34
$b-p_c$	-0.3	-0.2	0.02
$\Delta(b-p_c)$	-9.1	-3.9	1.92
t_1	-1.5	-1.5	0.05
Δt_1	-8.6	-4.1	1.90
t_2	-2.6	-1.8	0.22
Δt_2	-10.8	-3.1	2.32
t_3	-1.5	-0.9	0.16
Δt_3	-10.7	-4.1	2.30
y-n-h	-0.6	0.1	0.01
Δ(y-n-h)	-10.8	-3.6	2.34
mm	-1.8	-1.7	0.29
Δmm	-6.5	-5.5	1.47
Critical value	-2.86	-2.86	0.7 (approx upper band)

We have a number of choices at this stage. Engle and Granger (1987) suggest estimating the cointegrating vector directly using OLS, where only I(1) (or above) variables appear in the regression, and testing the residuals for stationarity. This cointegrating vector is then imposed, and the dynamics of the relationships estimated in the second stage regression. This contrasts with estimating both the long-run and dynamic relationships jointly using some form of autoregressive distributed lag formulation.

The advantages of a two-stage approach are two-fold. The first, often referred to as the 'super consistency' result, is that OLS estimates in the non-stationary case converge on their 'true' parameter values much faster than in the stationary case (see Stock (1984)). However, Banerjee et al (1986) suggest that in many cases small sample bias problems may be severe in the first stage regression. The second advantage of the two-stage procedure is practical; it makes segmenting an analysis of short and long-run behaviour a little easier. We use the two-stage approach in this chapter, but in doing so we do not wish to imply any belief that this approach is necessarily superior to more conventional estimation procedures.

In estimating the cointegrating vector we also have a choice between estimation by OLS, and using a maximum likelihood procedure developed by Johansen. Johansen (1988) derives maximum likelihood estimates for all the cointegrating vectors in any given set of variables and also a maximum likelihood test for the hypothesis that there are a certain number of cointegrating vectors. We first present results using Johansen's procedure, and then compare these with OLS estimates. Our data is quarterly, and is retrieved from the National Institute data base (see Appendix A2.1 for details).[4]

In our preliminary estimates, we typically found that real benefits ($b-p_c$) or any measure of the replacement ratio were incorrectly signed. We also found that real import prices ($pm-p_c$) and the employers tax wedge (t_1) were insignificant and wrongly signed in our long-run model. We will comment in more detail on this result below. Excluding these variables gives the results reported in Table 2.5.2. Our long-run vector of variables includes real earnings ($w-p_c$), the employers' tax wedge t_2, the indirect tax wedge t_3, productivity ($y-n-h$), industrial mis-match (mm) and the short-term unemployment rate (us).

Table 2.5.2 Likelihood ratio tests

r	LR Value	95% critical value
0	131.9	78.1
1	88.9	57.9
2	47.9	38.0
3	19.8	23.2
4	2.7	12.1
5	0.3	3.9

The likelihood ratio tests that there are at most r cointegrating vectors. It suggests that there are at most two cointegrating vectors within our set of variables.

The maximum likelihood estimates of all the eigenvectors together with the corresponding eigenvalues are given in Table 2.5.3.

Table 2.5.3 Johansen's maximum likelihood estimates (1967Q1-1987Q4)

Eigenvalue	$w-p_c$	us	t_2	t_3	y-n-h	mm
0.416	-1	0.85	21.22	-3.29	-7.84	0.80
0.401	-1	-0.09	0.57	-0.82	1.13	0.02
0.296	-1	-0.06	-0.16	1.35	0.83	0.04
0.191	-1	0.04	0.35	-0.83	0.82	-0.00
0.0391	-1	-0.29	5.98	1.62	0.91	0.01
0.004	-1	-1.15	13.7	8.15	7.76	0.13

Since we are interested in a wage equation, the eigenvectors are normalised so that $w-p_c$ takes the value -1. The two cointegrating vectors are given by the two largest eigenvalues. The vector corresponding to the eigenvalue 0.416 does not yield an immediate economic interpretation but the larger coefficient of t_2 suggests that this is a t_2 vector. The cointegrating vector for the eigenvalue 0.401 has the correct sign and order of magnitude for every coefficient for it to be interpreted as a wage equation. This cointegrating vector indicates that real earnings have an elasticity of -0.09 with respect to short-term unemployment; a one per cent cut in indirect taxes would have nearly the same effect on real earnings as one per cent cut in direct taxes (in fact an indirect tax cut is slightly more effective in the long run), the coefficient on productivity is not very different from 1 in the long run and structural mismatch has a small impact on real earnings.

We now compare the above results with the OLS estimate of the same variables in Table 2.5.4. The equation also included a constant as a scaling factor. The 't-statistics' are given in the brackets, although these are biased (upwards).

Table 2.5.4 OLS estimates of the cointegrating vector(67Q1-87Q4)

$w-p_c$	us	t2	t3	y-n-h	mm
-1	-0.03	0.51	-0.64	0.96	0.01
	(2.99)	(4.33)	(7.38)	(2.99)	(4.50)

$R^2 = 0.979$ DW = 1.04 DF = 5.34 ADF = 3.16

Autocorrelation function, Box Pierce and Ljung box statistics

Lag	1	2	3	4	5	6	7	8
Coeff.	0.4793	0.2873	0.0363	-0.0283	0.0483	0.003	-0.0439	-0.0
Box Pierce	19.30	26.23	26.34	26.41	26.57	26.57	26.74	30.1
Ljung	20.00	27.27	27.39	27.46	27.63	27.64	27.82	31.6

All the estimated coefficients have the correct sign. Furthermore, it is interesting to note that they also have the same order of magnitude as the Johansen estimates. The equation also shows strong signs of cointegration as indicated by the cointegrating Durbin-Watson, and Dickey-Fuller statistics. The Augmented Dickey-Fuller test (AUDF) rejects cointegration (see Engle and Yoo (1988)). However, this test is known to have weak power, and so it alone seems insufficient to contradict the implications of the other two tests and the Johansen results. In addition the correlogram looks fairly flat.

Engle and Granger (1987) state that any of the variables in a cointegrating vector can be regarded as the dependent variable. Hall (1989) suggests that the coefficient obtained from the Johansen estimates should lie in the range of coefficients obtained by OLS estimation when each variable is used in turn as the dependent variable. Table 2.5.5 gives the OLS estimates when the variable indicated on top is used as the dependent variable. All coefficients are normalised so that w-pc takes the value -1. Our Johansen estimates do indeed fall in the range of OLS estimates of Table 2.5.5.

Table 2.5.5 OLS estimates (67Q1 87Q4)

	$w-p_c$	t_2	t_3	y-n-h	us	mm
$w-p_c$	-1	-1	-1	-1	-1	-1
c	-0.045	-0.941	-0.350	-0.085	-1.303	-0.301
t_2	0.514	2.648	0.059	0.461	1.778	1.144
t_3	-0.644	-0.074	-1.566	-0.667	0.0737	-0.189
y-n-h	0.964	0.864	0.003	-0.049	-0.295	-0.084
mm	0.010	0.022	0.003	0.009	0.028	0.049

A number of variations of this cointegrating vector were tried.

1) Short versus total unemployment rate

When we estimated the above long-run equations with the total and medium-term (less than twelve months) unemployment rates, the elasticity of unemployment fell in absolute terms in both cases. When the short, medium and total unemployment rates were added together, only the short-run rate was significant. We also tried the total unemployment rate together with the proportion of those in the stock of unemployment who had been out of work for more than twelve months. The coefficient on the latter variable was positive and highly significant, a result also obtained by Layard and Nickell (1986). This confirmed the view that the short-term unemployment rate is the best measure of unemployment in a long-run vector of wages.

2) Employers' tax wedge, replacement ratio, house prices and real import prices

We found that employers' tax wedge was wrongly signed and insignificant in our cointegrating vector, and we dropped it; other authors studying the behaviour of UK earnings have found similar results, e.g. Nickell and Andrews (1983) and Layard and Nickell (1986).

Unlike Minford (1983), we did not find any impact from the replacement ratio on earnings. The variable was not only insignificant but it was also wrongly signed.

Motivated by Bover, Muellbauer and Murphy (1988), we included a price index for new houses in our cointegrating vector. This index was insignificant, it knocked out the mismatch variable and made our unemployment variable wrongly signed. In addition, the resulting equation did not cointegrate as well as the above long-run vector. We included an import tax wedge in our cointegrating vector but the variable was insignificant and wrongly signed.

3) Productivity

In the literature on wages two measures of productivity are typically used, output per man or man hour, Y/N and Y/NH, and the capital labour ratio, K/L. The capital stock data is often very unreliable, and unlike other authors, we were reluctant to estimate our own data, so we decided against K/L. Also, the UK economy is characterised by trend changes in working hours, H, alone so Y/N alone could be, at times, an inaccurate measure of productivity.

Our preferred productivity variable was therefore Y/NH. When we included Y/N and H separately in the cointegrating vector their estimated parameters were almost exactly equal to the opposite sign.

4) Profits

Carruth and Oswald (1986) have argued that a measure of profitability has to be included in a wage equation; in a later paper, Blanchflower, Garrett and Oswald (1988) conclude that their preferred measure of profits is real profits per head. We tried real profits per head in our cointegrating vector, but it was insignificant and wrongly signed. Carruth and Oswald (1989) also argue that profits and productivity can be regarded as alternatives, so we subsequently included real profit per man and dropped productivity from the long-run vector to obtain the equation below

Table 2.5.6

OLS estimates with real profits per man(67Q1-87Q4)

$$(w-p_c) = \underset{(9.43)}{2.09} + \underset{(1.21)}{0.34}\, t_2 - \underset{(2.45)}{0.49}\, t_3$$

$$+ \underset{(11.11)}{0.20}\, us + \underset{(3.88)}{0.02}\, mm + \underset{(9.74)}{0.23}\, (\pi-n)$$

$R^2 = 0.89$ SE = 0.0419 DW = 0.49

where π is real profits. The profits variable is significant but the equation does not cointegrate and the sign of unemployment is counter intuitive. However, this may not be a satisfactory test for the inclusion of profits in the wage equation given the interaction between profits, output per man and the capital-labour ratio. In fact, Carruth and Oswald (1989) include both real profits per man and the capital-labour ratio in their wage equations. Table 2.5.7 re-estimates the equation presented in Table 2.5.6 with the addition of the capital-labour ratio.

Table 2.5.7

OLS estimates with real profits per man and capital-labour ratio

Sample: 67Q1-87Q4

$$(w-p_c) = \underset{(2.57)}{0.65} + \underset{(4.32)}{0.79}\, t_2 + \underset{(1.79)}{0.26}\, t_3$$

$$+ \underset{(0.26)}{0.00}\, us + \underset{(4.68)}{0.02}\, mm + \underset{(5.53)}{0.12}\, (\pi-n) + \underset{(12.19)}{1.00}\, (k-n)$$

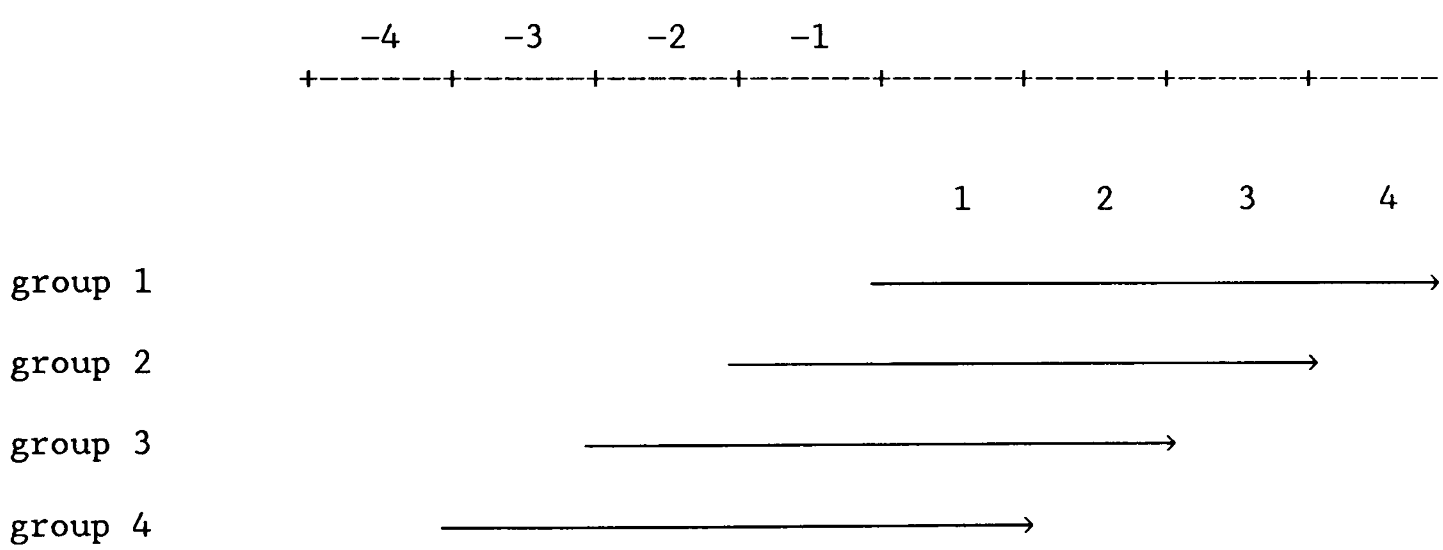
$R^2 = 0.95$ SE = 0.0285 DW = 0.57

Again the profit variable is highly significant and the capital–labour ratio has the correct sign and magnitude. However, the unemployment variable is now insignificant and the indirect tax wedge has a counter intuitive sign. We also included profits in the unrestricted version of our dynamic model, the results are presented in Appendix A2.2. Here the variables are correctly signed but profits, with Carruth and Oswald's best lag of six periods, is insignificant. The clarification of the role of profits in the wage equation does require further research.

2.6 The dynamics of wage contracts

Wage agreements are typically made annually in the UK, and last for one year. This has two consequences. Firstly, recorded earnings in quarter t will reflect not only agreements made at time t, but also the results of agreements at time t−1, t−2 and t−3. Secondly agreements made at time t could potentially involve expectations of events in periods t+1, t+2 and t+3 over which the agreement will hold.

The dynamic process of wage formation can be depicted as follows:



So in each period there are four overlapping contracts but only one is renegotiated.

Assume that each group has a desired level of real wage $(W/P)^*_t$ which is identical, and that exactly 1/4 of wage bargainers settle each quarter. In period t group 1 sets nominal wages (W^1). The annual contract implies:

$$W^1_t = W^1_{t+1} = W^1_{t+2} = W^1_{t+3} \tag{2.6.1}$$

We then have:

$$1/4\sum_{i=0}^{3}\ln(W/P)^{*}_{t+i} = 1/4\ \Sigma\ \ln\ (W^{1}_{t+i}/P_{t+i})$$

$$= \ln W^{1}_{t} - 1/4\ \Sigma\ \ln P_{t+i} \qquad (2.6.2)$$

Therefore

$$\ln W^{1}_{t} = 1/4\sum_{i=0}^{3} \ln(W/P)^{*}_{t+i} + 1/4\sum_{i=0}^{3}\ln P_{t+i} \qquad (2.6.3)$$

Similarly for group 2:

$$\ln W^{2}_{t-1} = 1/4\sum_{i=0}^{3} \ln(W/P)^{*}_{t+i-1} + 1/4\sum_{i=0}^{3} \ln P_{t+i-1}$$

and for groups 3 and 4

$$\ln W^{3}_{t-2} = 1/4\sum_{i=0}^{3} \ln(W/P)^{*}_{t+i-2} + 1/4\sum_{i=0}^{3} \ln P_{t+i-2}$$

$$\ln W^{4}_{t-3} = 1/4\sum_{i=0}^{3} \ln(W/P)^{*}_{t+i-3} + 1/4\sum_{i=0}^{3} \ln P_{t+i-3}$$

Aggregate nominal wages are given by:

$$\ln W_{t} = 1/4\sum_{j=0}^{3} \ln W^{j}_{t}$$

since

$$W^{j}_{t-i} = W^{j}_{t} \qquad i = 1,2,3$$

then from (2.6.1)-(2.6.3):

$$\ln W_{t} = 1/16[\sum_{i=0}^{3}(4-i)(\ln(W/P)^{*}_{t-i} + \ln P_{t-i}) + \sum_{i=0}^{3} (4-i)(\ln(W/P)^{*}_{t+1} + \ln P_{t-i})]$$

$$(2.6.4)$$

Therefore

$$\ln(W/P)_t - \ln(W/P)^*_t = 1/16\,[\,(\Delta\ln(W/P)^*_{t+3} + \Delta\ln P_{t+3}) + 3(\Delta\ln(W/P)^*_{t+2} + \Delta\ln P_{t+2}) + 6(\Delta\ln(W/P)^*_{t+1} + \Delta\ln P_{t+1}) - 6(\Delta\ln(W/P)^*_{t} + \Delta\ln P_{t}) - 3(\Delta\ln(W/P)^*_{t-1} + \Delta\ln P_{t-1}) - (\Delta\ln(W/P)^*_{t-2} + \Delta\ln P_{t-2})\,] \quad (2.6.5)$$

The existence of wage contracts therefore means that aggregate earnings are likely to involve both forward and backward looking dynamics in a symmetrical fashion. As future prices and the determinants of desired real wages are unknown, the forward-looking elements will involve expectations. In principle these expectations will involve all the elements entering $(W/P)^*$ (e.g. unemployment) as well as prices. However, modelling expected $(W/P)^*$ involves a large number of difficult issues. For example, is it more reasonable to assume that expectations about tax rates are rational or static? Preliminary econometric results of our own suggest that it would not be reasonable to treat all the elements of $(W/P)^*$ identically in this respect. For simplicity, we focus on price expectations, leaving issues involving expected unemployment, tax rates etc. for later study. This emphasis follows that in the literature, which has focused almost exclusively on <u>price</u> expectations when analysing wage behaviour.

There are three main approaches to modelling expected prices. The first is to use the rational expectations hypothesis, which effectively allows us to proxy expected prices by actual outturns. The second constructs explicitly expected price data from survey information (Parkin et al (1976)). The third replaces expected prices by lagged prices and possibly other lagged variables, and estimates a general autoregressive distributed lag (ADL) or error correction model. This third approach can be given two interpretations. The first is that it represents a reduced form, embodying some unspecified and unidentified expectations model. The second is that agents do not form explicit expectations, but instead use simple rules of thumb in setting wages based on past information. This second interpretation is contrasted with the rational expectations approach in Hendry (1988).

In this chapter we estimate two alternative dynamic models of earnings behaviour. The first uses the rational expectations hypothesis, and applies the dynamics given in (2.6.5). (For convenience we will describe this as the forward looking rational expectations (FLRE) model). The second estimates a reduced form with no explicit expectations terms, and therefore does not impose the structure of dynamics implied by wage contracts. We then use some of the ideas put forward in Hendry (1988) to compare the two models.

Our interest in contrasting these two approaches is partly methodological, but it also stems from the quite different forecasting implications of the two equations. If a wage equation incorporating the dynamics in (2.6.5) and rational expectations is embodied in a full model, then under consistent expectations anticipated changes in prices will lead to an initial rise in the real wage. In contrast, in a reduced form or rule of thumb model there will always be some form of price change which will initially reduce real wages.

Our two dynamic models take the following log-linear form. The forward looking version can be written as:

$$w-p = (1 - \alpha)(w-p)_{-1} + \alpha(w-p)^{c}_{-1} + \Phi_{i}(L)z_{i} + \theta(L)\Delta p \qquad (2.6.6)$$

where w-p is real wage and $(w-p)^c$ is the cointegrating vector for real wages estimated in section 2.3, and z_i are components of this cointegrating vector. This essentially involves a single error correction model for real wages, where the desired level is given by the cointegrating vector, but where Φ_i is be data-based, thus we make no attempt to capture the aspect of the dynamics implied by (2.6.5). In contrast, the form of $\theta(L)$ is exactly that implied by (2.6.5), i.e.

$$\theta(L) = {}^{1}/16\ [L^{-3} + 3L^{-2} + 6L^{-1} - 6 - 3L - L^{2}] \qquad (2.6.7)$$

Where $\theta(L)$ involves the forward operator (i.e. L^i, $i \leqslant -1$), then inflation will involve expectations. It also seems reasonable, given the lags involved in the bargaining process, that current inflation will be unknown when current earnings are determined, so current inflation will also be an expected variable. We therefore need an additional hypothesis about the generation of expectations. Here we choose the Rational Expectations hypothesis, which in practice involves replacing expected inflation by actual future inflation in (2.6.6). We estimate this model using Instrumental Variable techniques, which involves setting up an implicit expectations generating equation (EGE) of the form:

$$\Delta p^{e} = \Omega_{i}(L)x_{i} \qquad (2.6.8)$$

where the vector of variables x_i will include past inflation, and using the elements of x_i as additional variables.

The 'backward looking' version of the model is:

$$w-p = (1 - \alpha')(w-p)_{-1} + \alpha'(w-p)^{c}_{-1} + \Phi'_i(L)z_i + \theta'(L)\Delta p + \Omega'_i(L)x_i \tag{2.6.9}$$

The key distinction here is that θ' and Ω' only involve L^i, $i \geqslant 1$, so that there are no current or future expected terms in price inflation. This equation can be interpreted in two ways. It could be a reduced form (BLRF) of (2.6.6) and (2.6.8). Alternatively it could be a structural model where agents use <u>rules of thumb</u> rather than generate explicit expectations concerning inflation. This could be termed the 'feedback model', but to make its structural character clear we will describe it as the backward looking structural model (BLSM). Finally note that if the BLSM is 'true', then we can still estimate (2.6.6), but it becomes a rather meaningless hybrid with no structural interpretation.

Neither of our dynamic equations contains any incomes policy variable. It seems reasonable to assume that incomes policy effects should not appear in the cointegrating vector; even its strongest advocates are unlikely to claim that an incomes policy could permanently lower real wages. However our analysis of dynamics would be improved if we could successfully capture the temporary effects of incomes policy periods on earnings. The difficulty here derives from problems in measuring the strength and success of each phase of these policies adequately. Picking out some of these policies and not others with 0/1 dummies is fairly arbitrary, and is also open to data mining.

2.7 Two dynamic models

We first present the forward looking (FLRE) model. To be able to directly compare the two dynamic models we deflate earnings by lagged prices. Current prices are estimated using instrumental variables.

In (2.6.6) the term $\theta(L)\Delta p$ has a coefficient of unity. In Table 2.7.1 it is freely estimated, but at a value insignificantly different from unity. The cointegrating vector for wages is highly significant. Dynamic terms in two components of the cointegrating vector proved to be significant: productivity and mismatch. The productivity term lengthens the average lag before productivity changes that are implied by the error correction term feed into wages, while the mismatch term has the opposite effect.

Table 2.7.1 The forward looking (FLRE) model-Instrumental Variable

$$\Delta(w-p_c(-1)) = \underset{(4.46)}{0.0069} + \underset{(4.41)}{0.867}\ (\theta(L)+(1-L))\Delta p + \underset{(2.12)}{0.194}\ \Delta(w-p_c(-1))_{-2}$$

$$+ \underset{(3.97)}{0.302}\ (w^c-w)_{-1} - \underset{(3.14)}{0.444}\ \Delta(y-n-h) + \underset{(2.48)}{0.005}\ \Delta mm$$

Sample period is 1967Q2-87Q1

$\bar{R}^2 = 0.44$ SE = 0.0117 DW = 1.92 Sargan $\chi^2(2) = 4.35$

LM (4) = 7.53; Ramsey's RESET $\chi^2(1) = 0.13$; Normality $\chi^2(2) = 3.38$

Heteroscedasticity $\chi^2(1) = 1.68$

Instrumented variable: $(\theta(L)+(1-L))\Delta p$

Additional instruments: Δpm_{-1}, Δpw_{-1}, Δcex_{-1}

$\theta(L)$ is given by 2.6.7

$w-w^c$ is the residual from the cointegrating vector for real wages given in table in table 2.5.4

pm = log of import prices

pw = log of wholesale prices

cex = consumers' expenditure

The precise references for these series are given in the Data Appendix. The estimation was carried out using PC-Give and Datafit. The backward looking (BLSM) model can be estimated by OLS.

Table 2.7.2 The backward looking (BLSM) model-OLS

$$\Delta(w-p_c(-1)) = \underset{(2.38)}{0.004} - \underset{(5.06)}{0.744}\,(\Delta p_{-1} - \Delta p_{-3}) + \underset{(3.06)}{0.294}\,\Delta(w-p_c(-1))_{-1}$$

$$+ \underset{(4.17)}{0.464}\,\Delta(w-p_c(-1))_{-2} + \underset{(4.91)}{0.405}\,(w^c-w)_{-1} - \underset{(3.14)}{0.462}\,\Delta(y-n-h)_{-1}$$

Sample period is 1967Q2-87Q1

$\bar{R}^2 = 0.39$ SE = 0.0122 DW = 1.84

LM (4) = 3.81 ; Ramsey's RESET $\chi^2(1) = 0.05$; Normality $\chi^2(2) = 4.1$

Heteroscedasticity $\chi^2(1) = 2.49$; Chow's Predictive Failure $\chi^2(3)=1.62$

The dynamic structure of the backward looking model is similar to the forward looking (FLRE) model, with the main difference being the structure of the price dynamics. Only the lagged first and third differences in inflation are significant and there is of course no contract term. Dynamic price homogeneity requires the coefficients on these two price change terms to be the same, this is easily accepted by the data. Note that the feedback model has no dynamic terms in the mismatch variable. To compare the two dynamic equations we draw upon Hendry (1988) and PC-GIVE to explore the structural and parameter stability properties of the two equations.

Before we proceed we must check that our dynamic models encompass the unrestricted ECMs, if not, Banerjee et al (1986) have shown that the restricted models presented here may suffer from small sample bias. To test for this we estimate the unrestricted versions of the two models. This involves replacing the lagged residuals with all the individual variables which appear in the cointegrating vectors and then testing the restricted models of Tables 2.7.1 and 2.7.2 against these unrestricted versions. The unrestricted models are reported in

Appendix A2.2. The Wald tests with 5 degrees of freedom (we have six variables in our cointegrating vector), are 6.32 and 4.37 for the feedback and feedforward models respectively. The restricted versions thus encompass the freely estimated ECMs in which the lagged residuals are replaced with the individual variables in the cointegrating vector.

Figures 2.7.1 to 2.7.4 represent recursive estimates of the FLRE model. All coefficients pass the test of parameter stability. Figure 2.7.5 plots recursive tests for the residuals of the forward looking model. Figure 2.7.6 plots the result of including a series of 0-1 dummies at different points in time over the sample period to test structural stability of the model[5]; none of the dummies were significant. Figure 2.7.6a depicts the result of the 10 step ahead stability test whereby 0-1 dummies are included for each of the last ten quarters of the sample and the sample period is increased by one observation at a time. The forward looking model is stable on all accounts.

Figures 2.7.7 to 2.7.10 give the recursive estimates of the coefficients of the BLSM model. There is no serious sign of a structural break. However, some minor signs of a structural breakdown around 1976 can be seen from Figures 2.7.11, 2.7.12, 2.7.13 and 2.7.14. Figure 2.7.11 represents recursive residuals. Figure 2.7.12 depicts 1-step ahead Chow tests, Figure 2.7.13 shows increasing horizon Chow tests and Figure 2.7.14 is the plot of cumulated sum of squares of the recursive residuals for the backward looking model.

Hendry (1988) points out the importance of analysing the expectation generating model. Hendry shows that if the expectation generating model is unstable and the feedback model is stable then the forward looking model is encompassed by the feedback model. Here we employ an instrumental variable approach, so we do not have an explicit expectation generating model. However, we can regress the change in prices on all our instruments. The resulting recursive coefficients were all stable, but the equation exhibited signs of instability at the same points in time as the feedback equation. This is shown in Figure 2.7.15 which depicts the one step increasing Chow test for expectation generating equation and Figure 2.7.16 which shows the cumulative sum of squares of the recursive residuals. Finally, Figures 2.7.17 and 2.7.18 depict the fitted values for the forward looking and the backward model respectively.

Taken as a whole these results tend to support the forward looking (FLRE) model rather than the backward looking (BLSM) alternative. The first point is that the instability in the feedback model, although minor, occurs over the same periods as instability is observed in the implicit expectations mechanism. The second key result is that the forward looking model fits better (standard error 0.0117 compared to 0.0122)[6], despite the extra 'noise' generated by expectations errors. Both factors suggest that the backward looking model is not structural, and hence that FLRE encompasses BLSM.

2.8 Conclusion

In this paper we have investigated cointegrating vectors and dynamic models for UK average earnings. Our cointegrating vector related real earnings (defined in terms of consumer prices) to short term unemployment, productivity per man hour, a mismatch variable as well as direct and indirect taxes. This vector, which was estimated using both Ordinary Least Squares and Johansen's procedure, appeared to be reasonably robust. In particular we could find no strong additional role for terms of taxes on employment, real import prices, house prices, profitability or long term unemployment.

Taking our best cointegrating vector as given, we then estimated two alternative dynamic equations: a forward looking version which assumed agents formed rational expectations about future price inflation (where the precise dynamics came from analysis of annual wage contracts), and a backward looking model that depended on past price inflation. The latter could either be regarded as a reduced form involving an implicit expectations generating mechanism, or a structural model in which agents used rules of thumb rather than explicitly formulating expectations. We compared the two equations using techniques discussed in Hendry (1988). The evidence tended to favour the forward looking model although it was not strong enough to decisively reject the backward looking alternative. A reasonable conclusion would be that the backward model did not reject the proposition that agents formed rational expectations about inflation when agreeing nominal wage contracts.

Figure 2.7.1 Recursively estimated coefficients of $(\theta(L) + 1 - L)\Delta p$ for the forward looking (FLRE) model

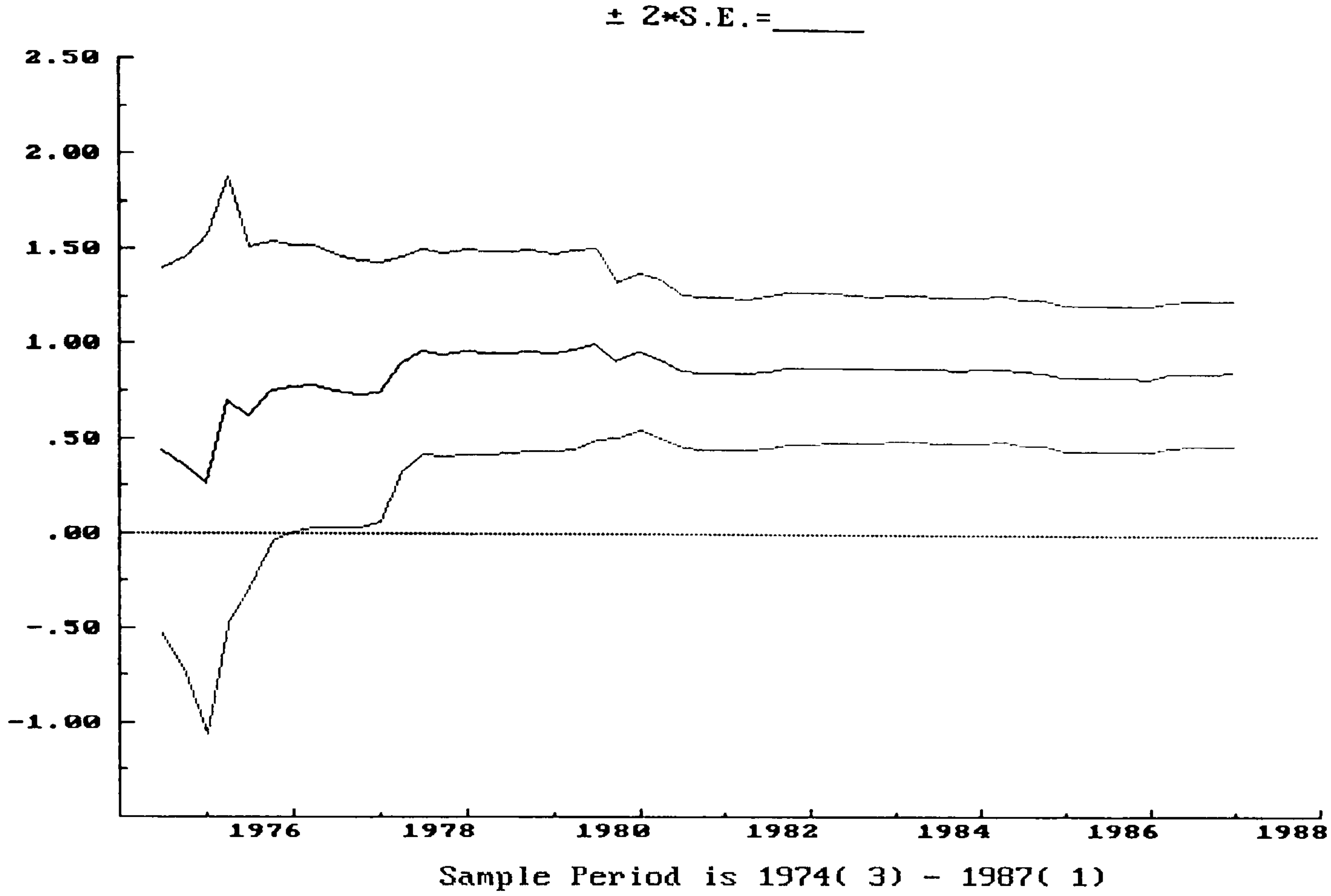


Figure 2.7.2 Recursively estimated coefficients of $\Delta(y-n-h)_{-1}$ for the forward looking (FLRE) model

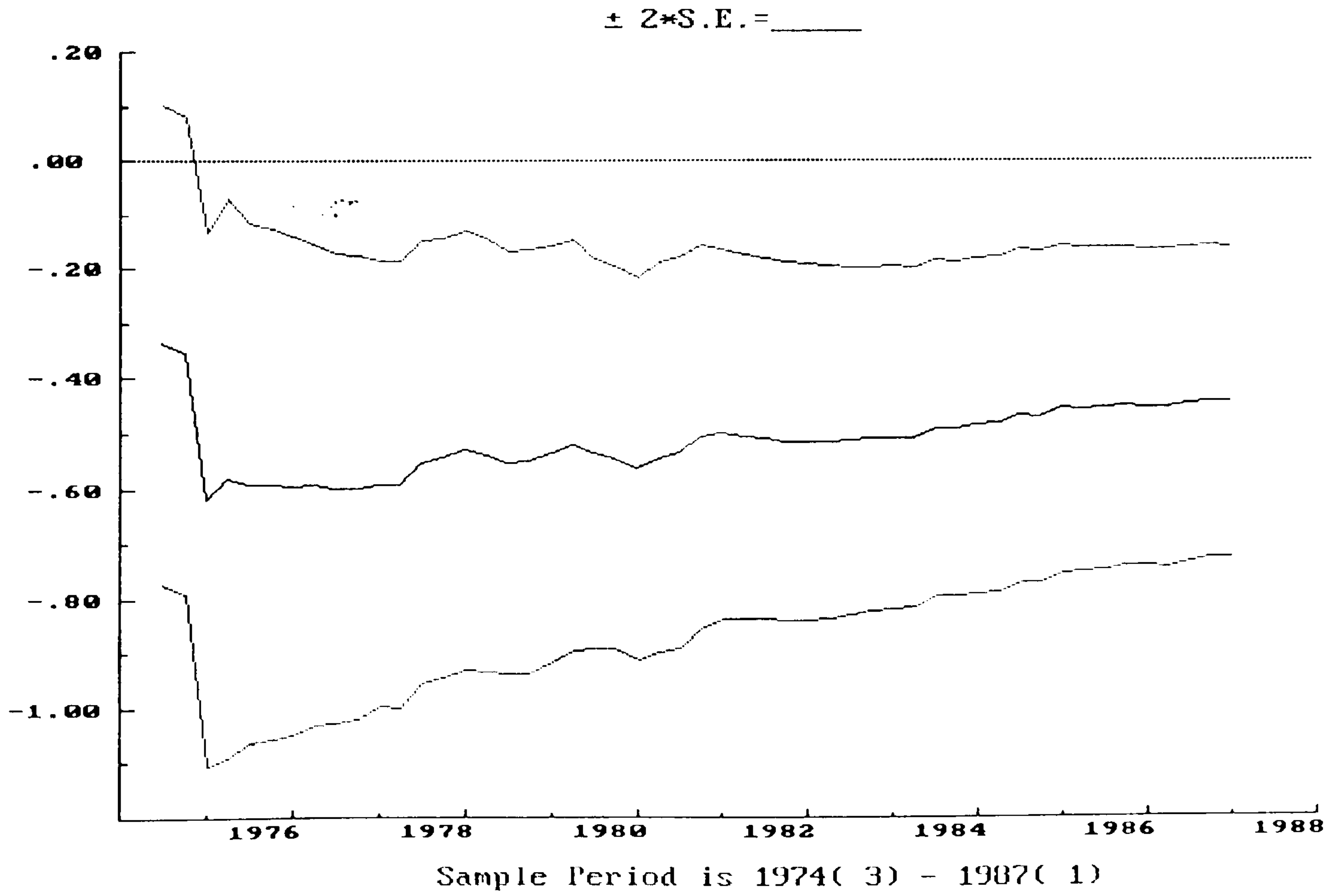
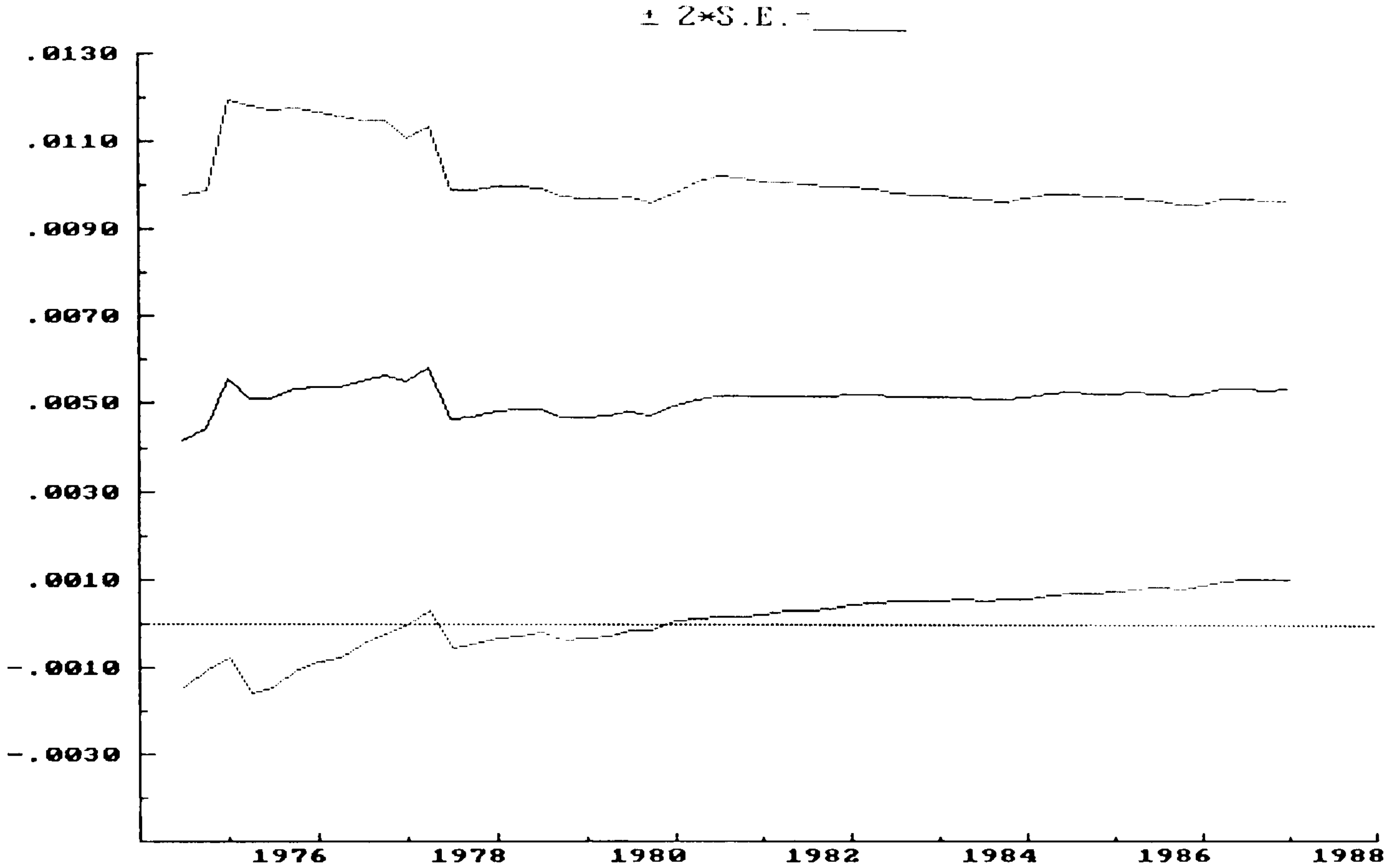
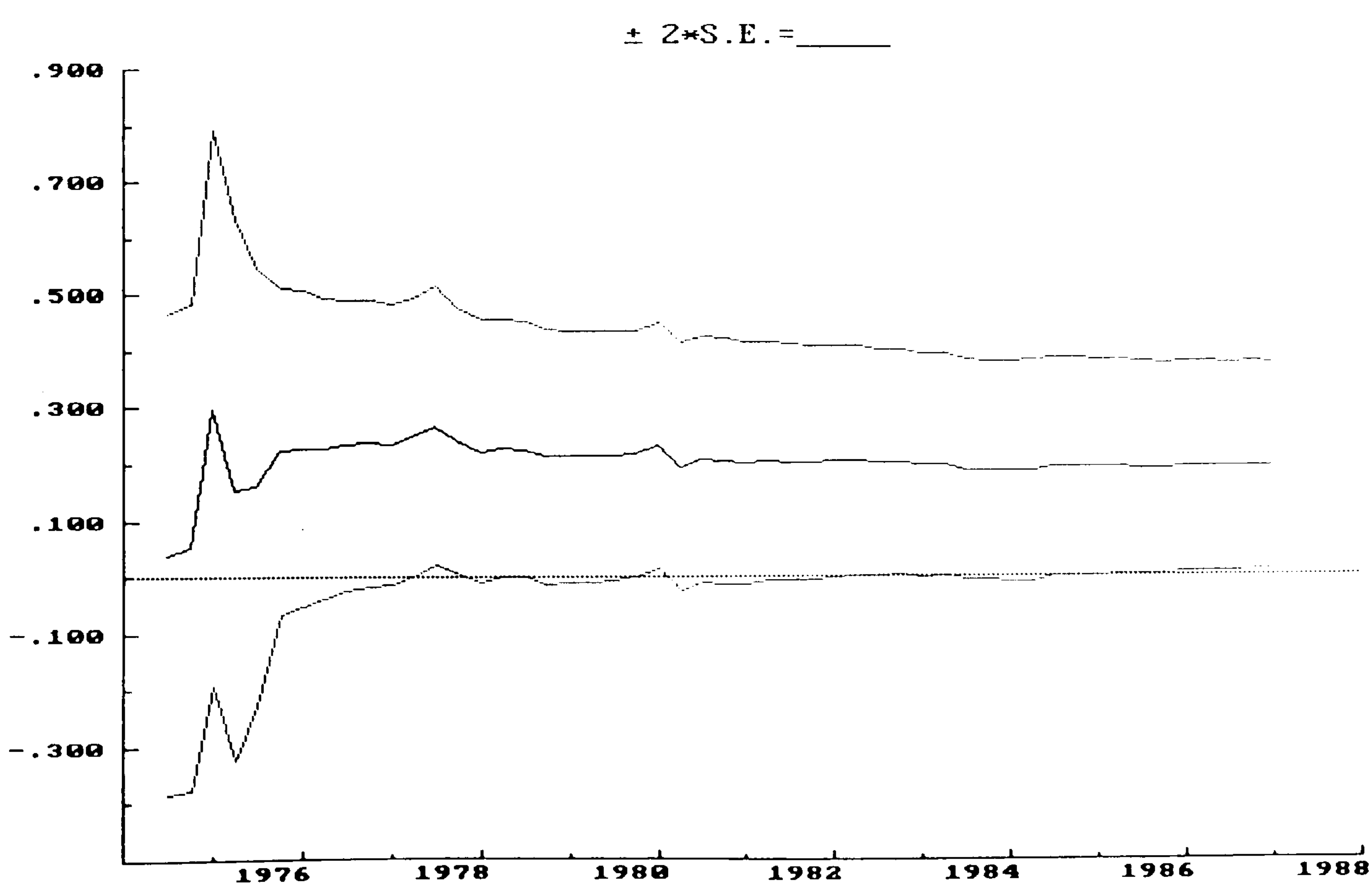


Figure 2.7.3 Recursively estimated coefficients of Δmm for the forward looking (FLRE) model



Sample Period is 1974(3) - 1987(1)

Figure 2.7.4 Recursively estimated coefficients of $\Delta(w-p_c(-1))_{-2}$ for the forward looking (FLRE) model



Sample Period is 1974(3) - 1987(1)

Figure 2.7.5 Recursive residuals for the forward looking (FLRE) model

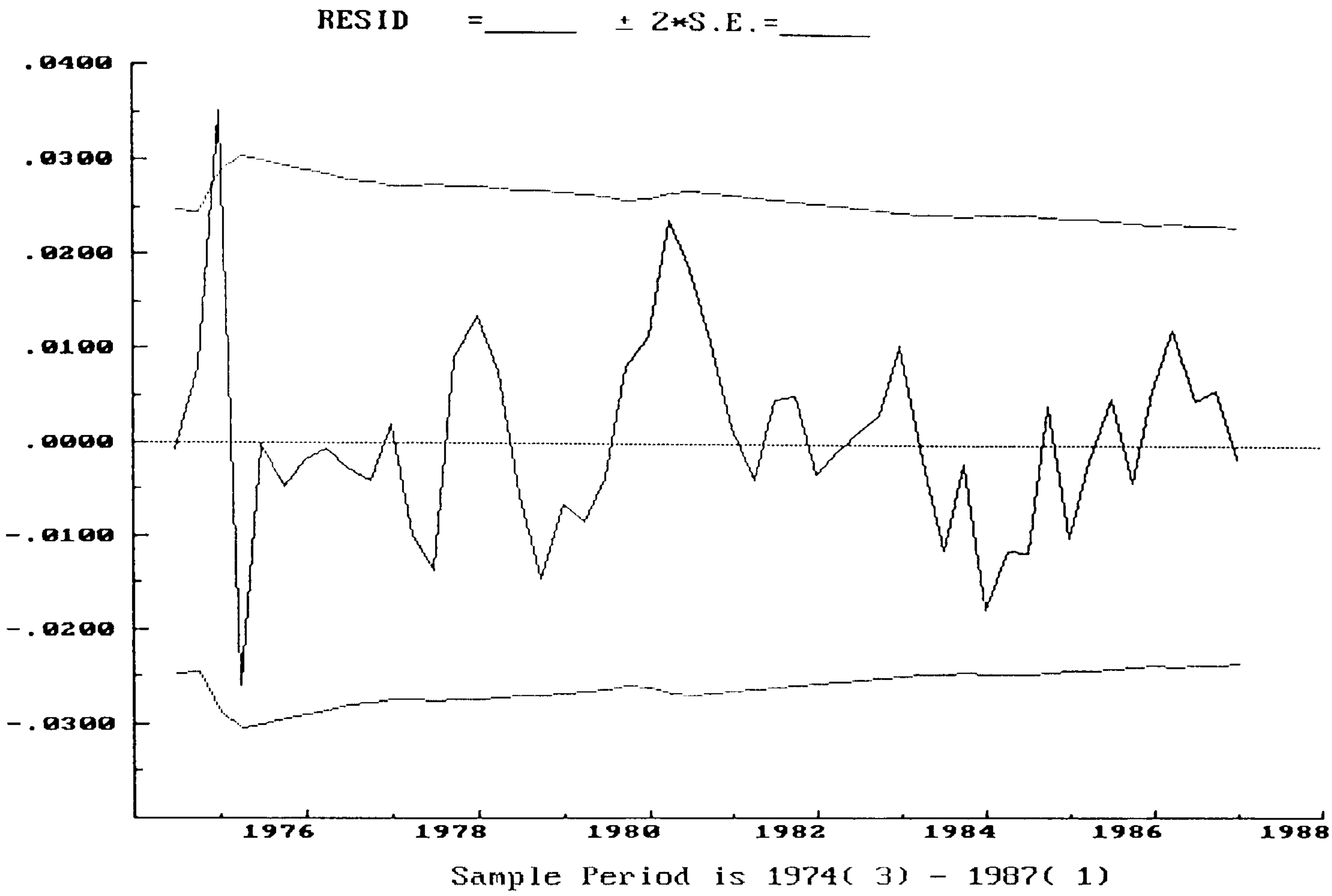


Figure 2.7.6 0-1 dummy test of structural stability

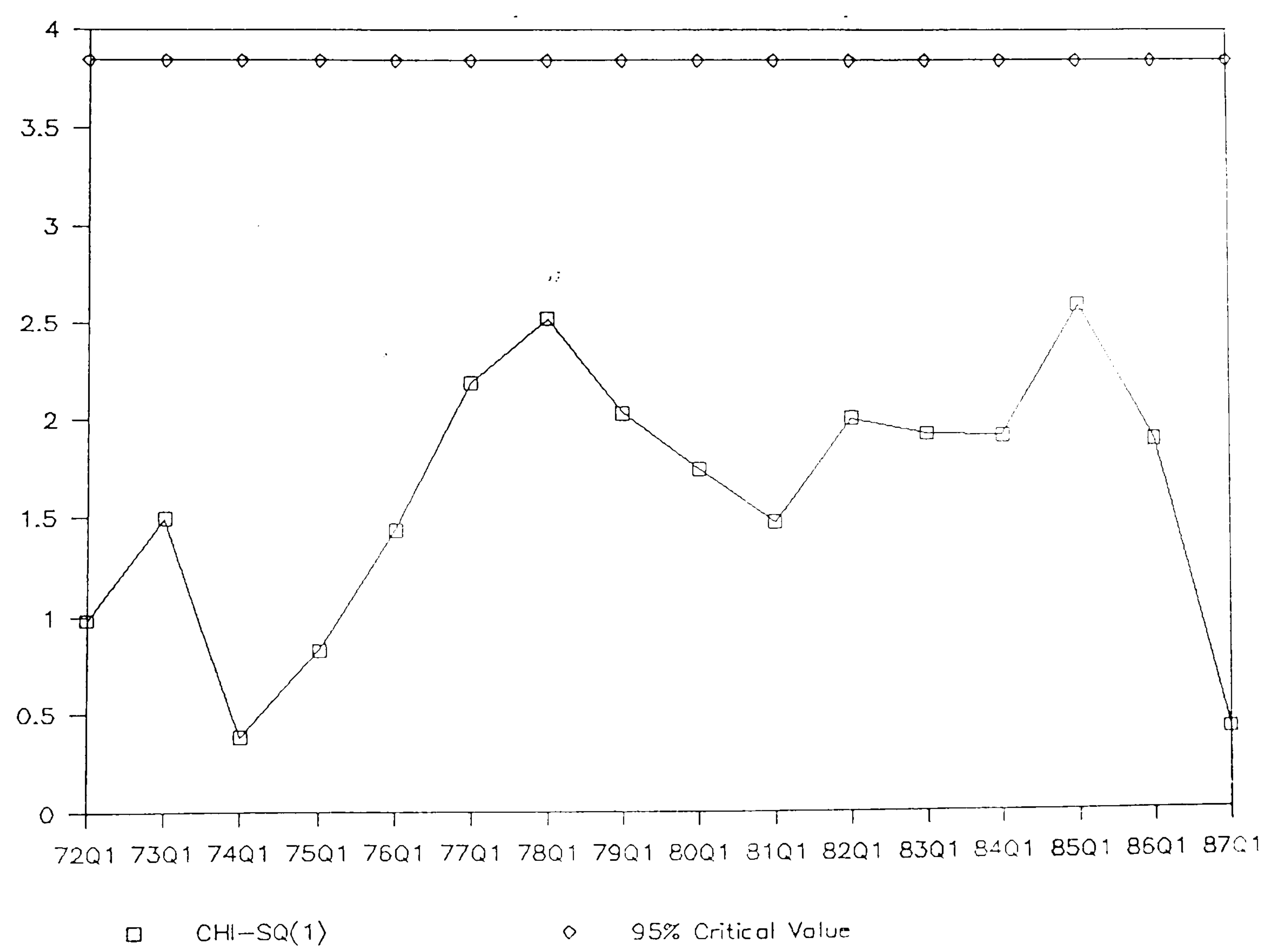


Figure 2.7.6a 10 step ahead 0-1 dummy test of structural stability

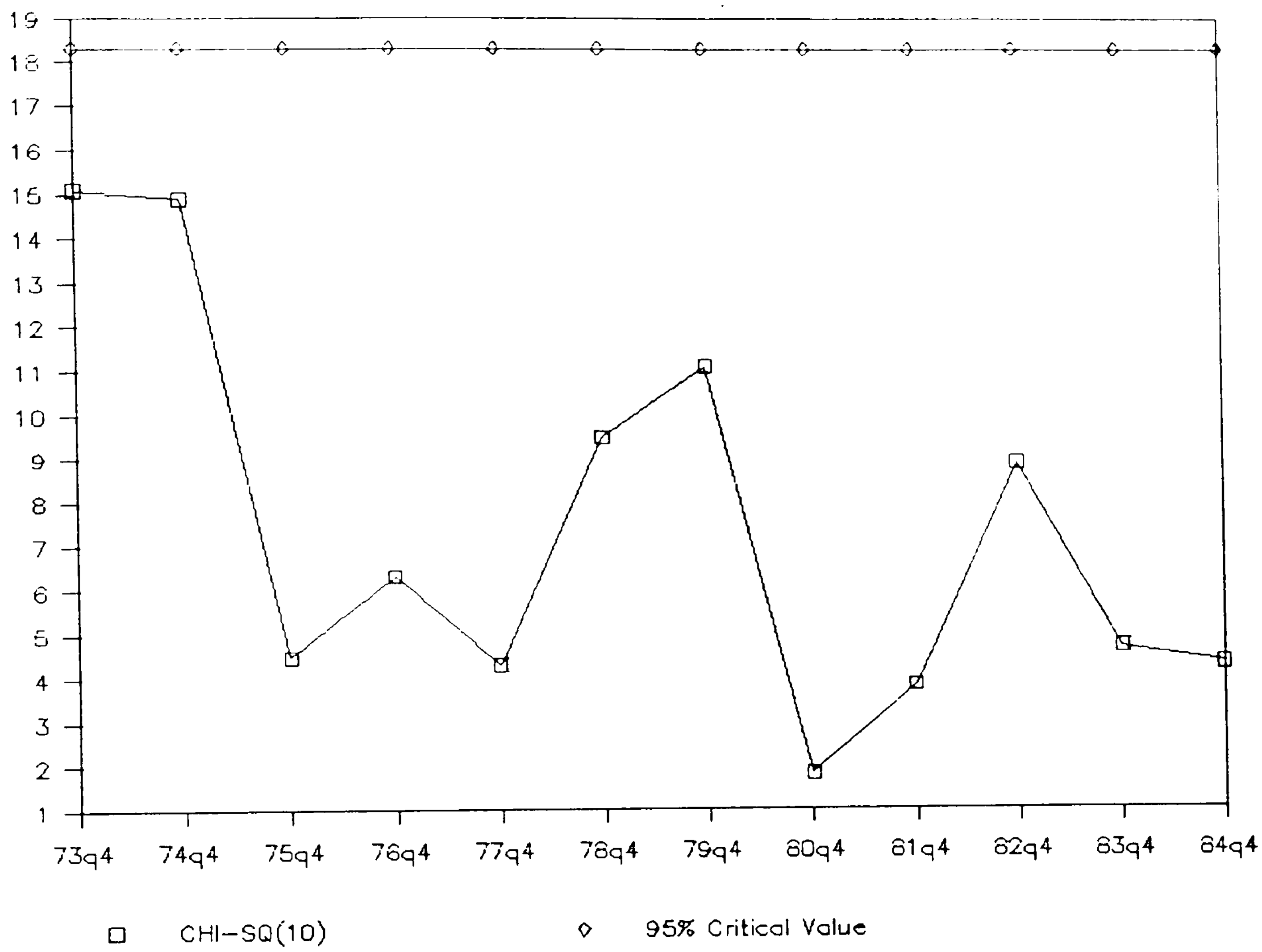


Figure 2.7.7 Recursively estimated coefficients of Δp_{-1}-Δp_{-3} for the backward looking (BLSM) model

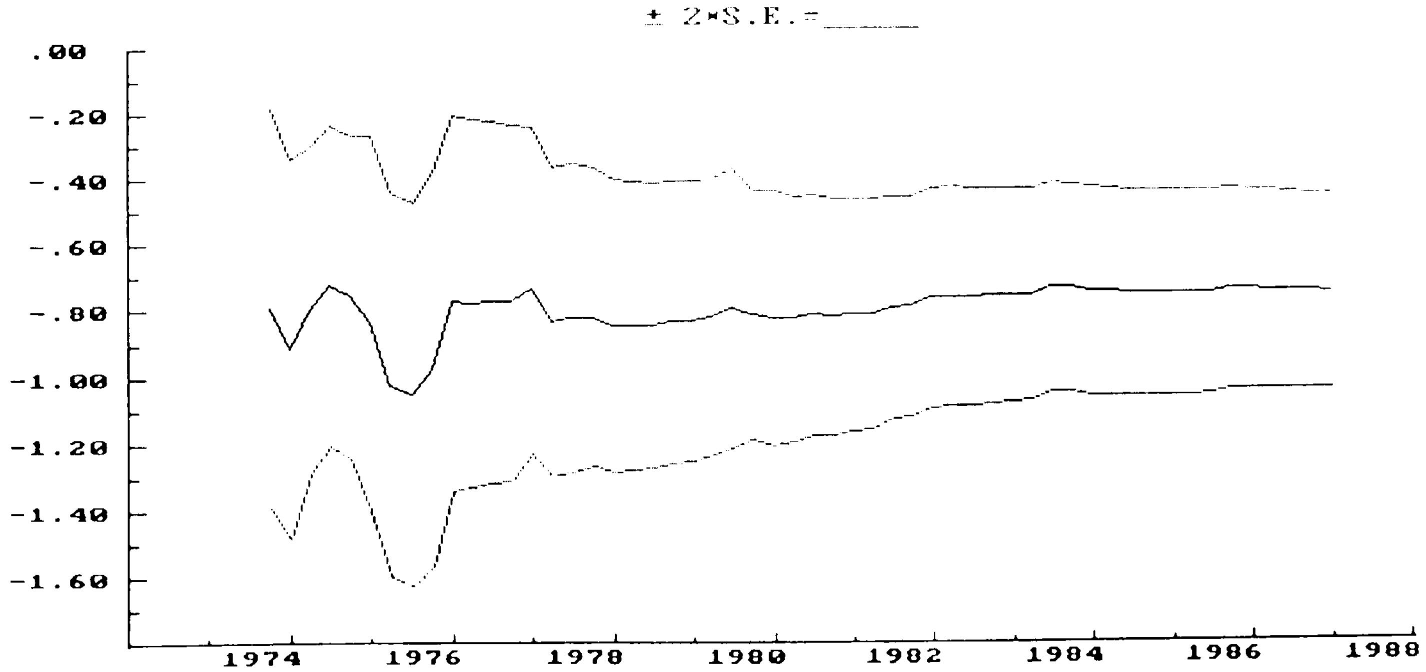


Figure 2.7.8 Recursively estimated coefficients of $\Delta(y-n-h)_{-1}$ for the backward looking (BLSM) model

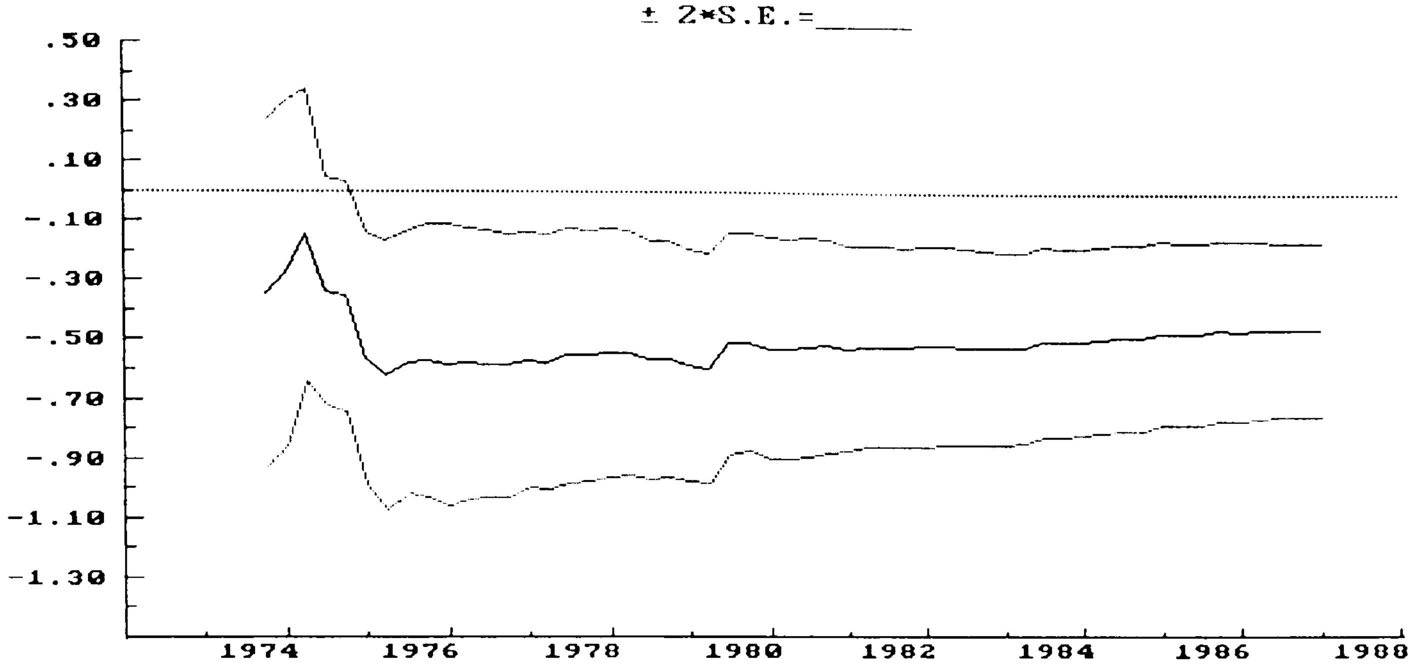


Figure 2.7.9 Recursively estimated coefficients of $\Delta(w-p_c(-1))_{-1}$ for the backward looking (BSLM) model

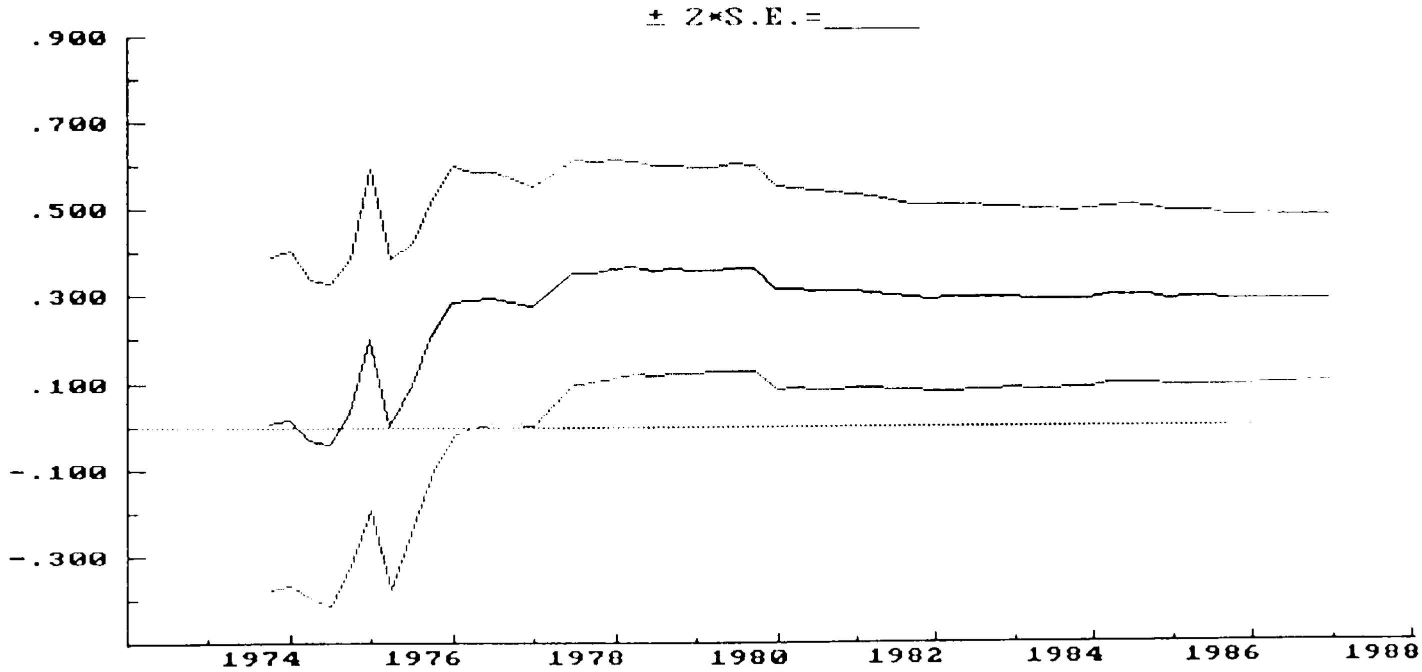


Figure 2.7.10 Recursively estimated coefficients of $\Delta(w-p_c(-1))_{-2}$ for the backward looking (BSLM) model

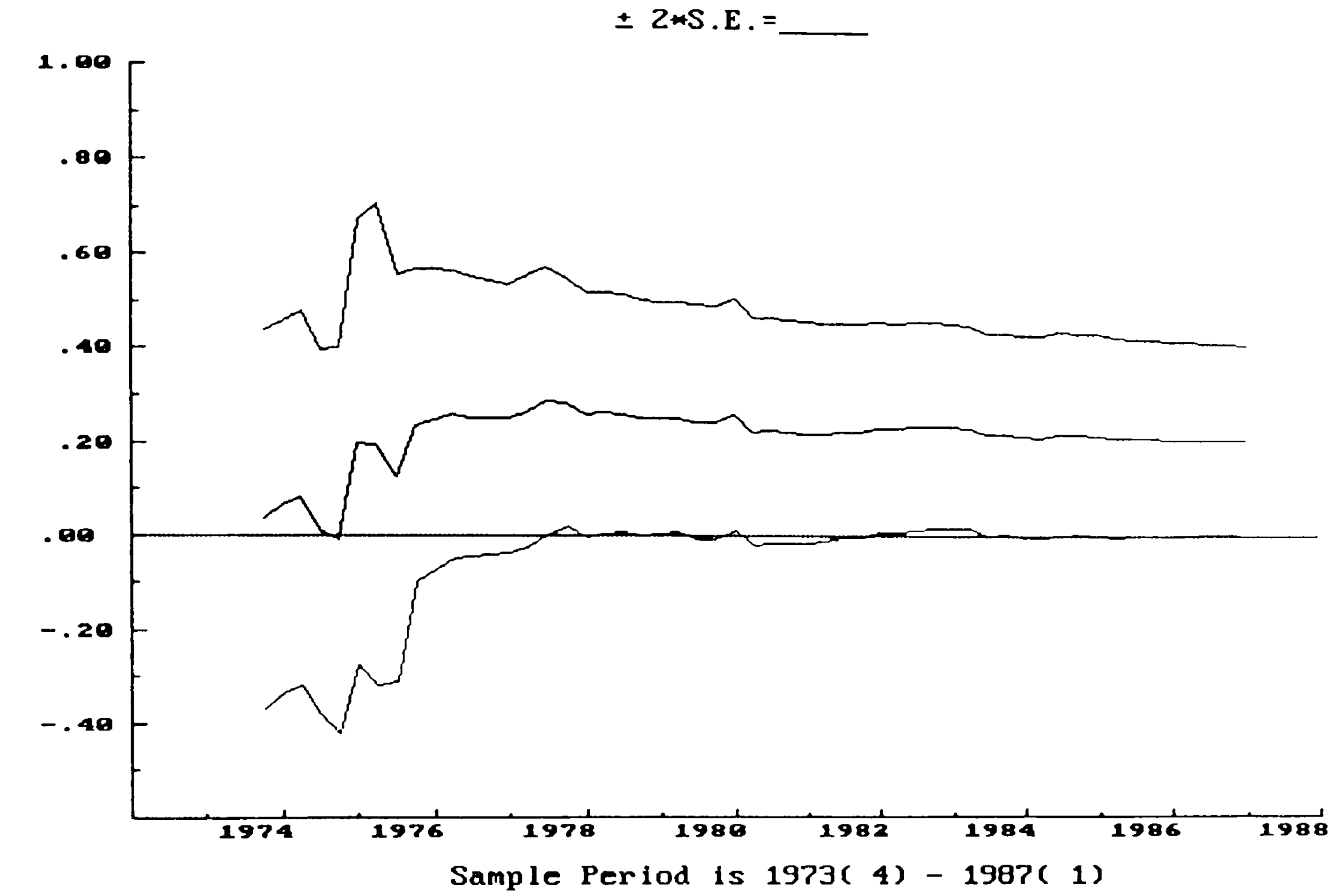


Figure 2.7.11 Recursive residuals of the backward looking (BSLM) model

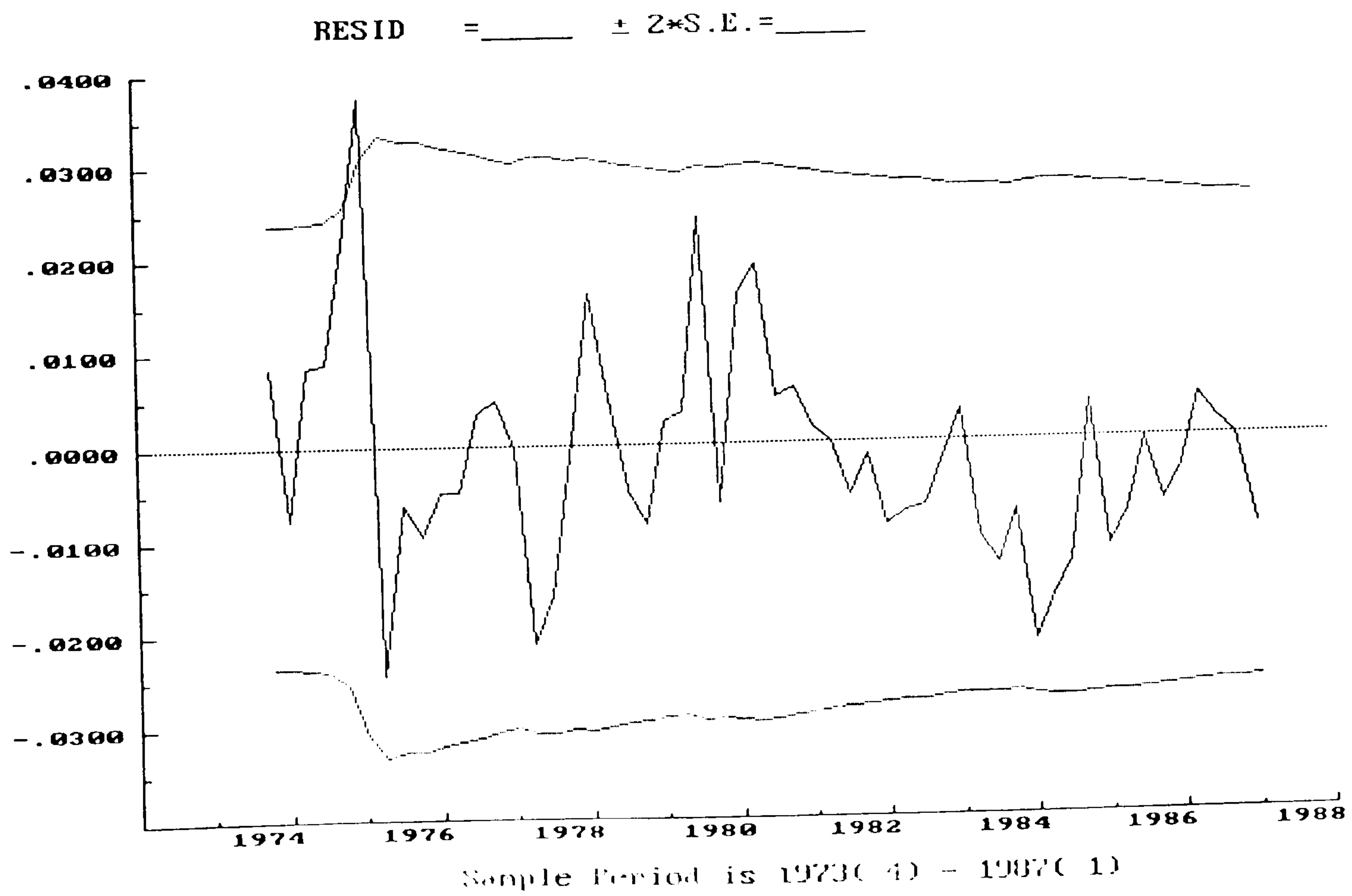


Figure 2.7.12 1-step Chow tests for the backward looking (BSLM) model

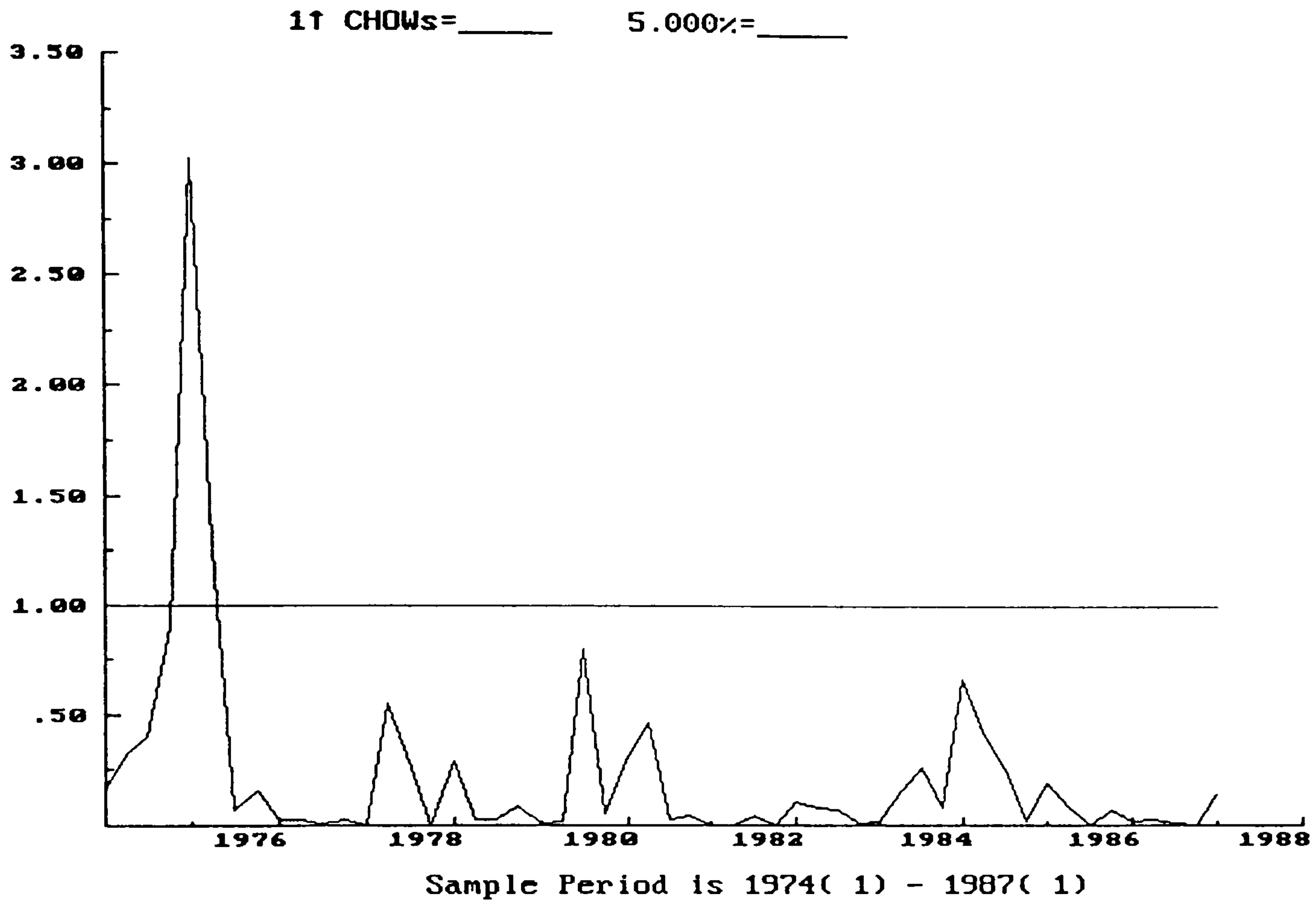


Figure 2.7.13 Increasing horizon Chow test for the backward looking (BSLM model

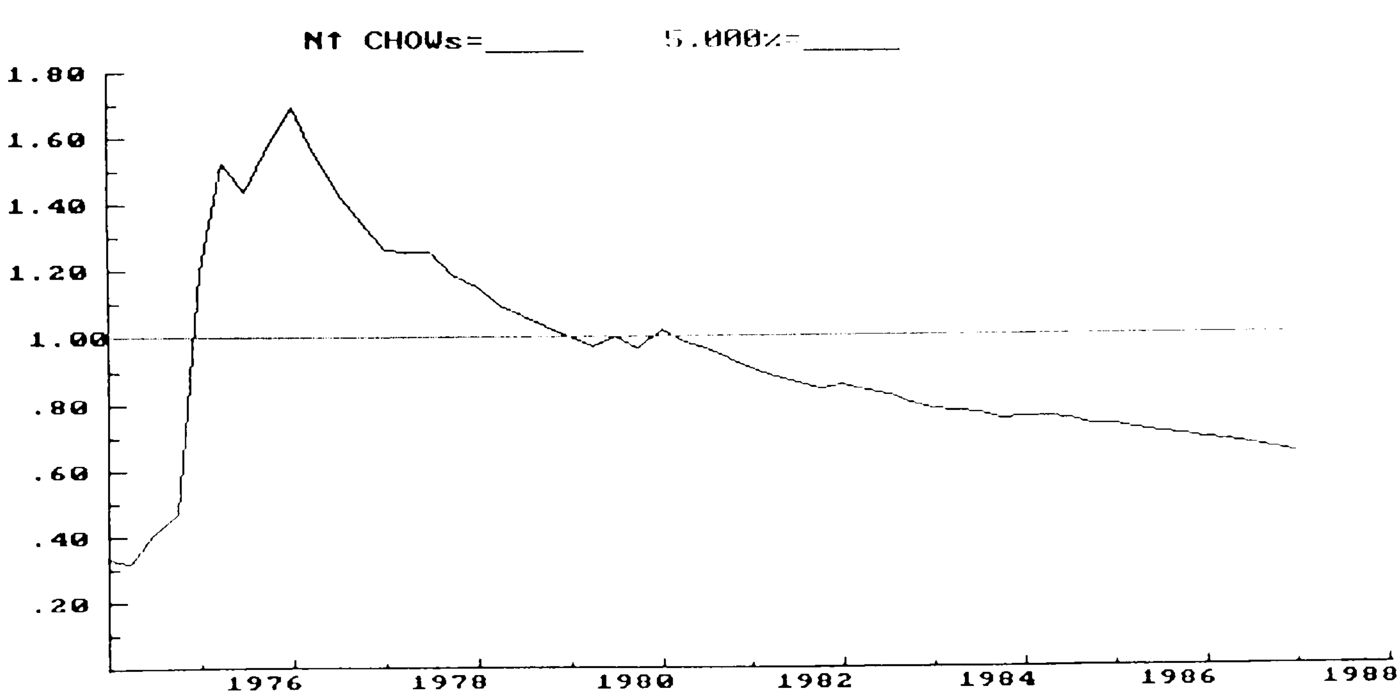


Figure 2.7.14 CUSUMSQ test for the backward looking (BSLM) model

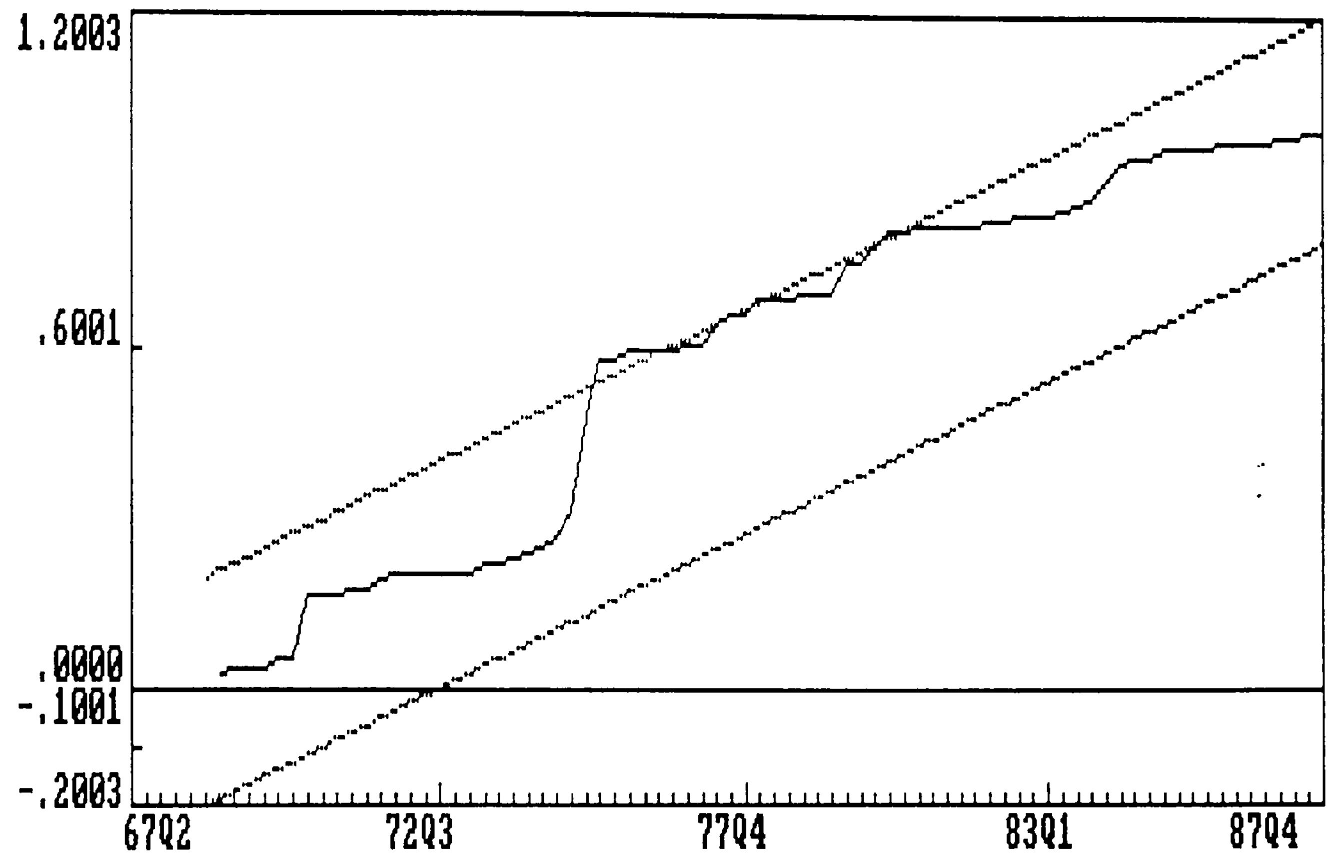


Figure 2.7.15 1-step Chow tests for the regression of Δp on instruments

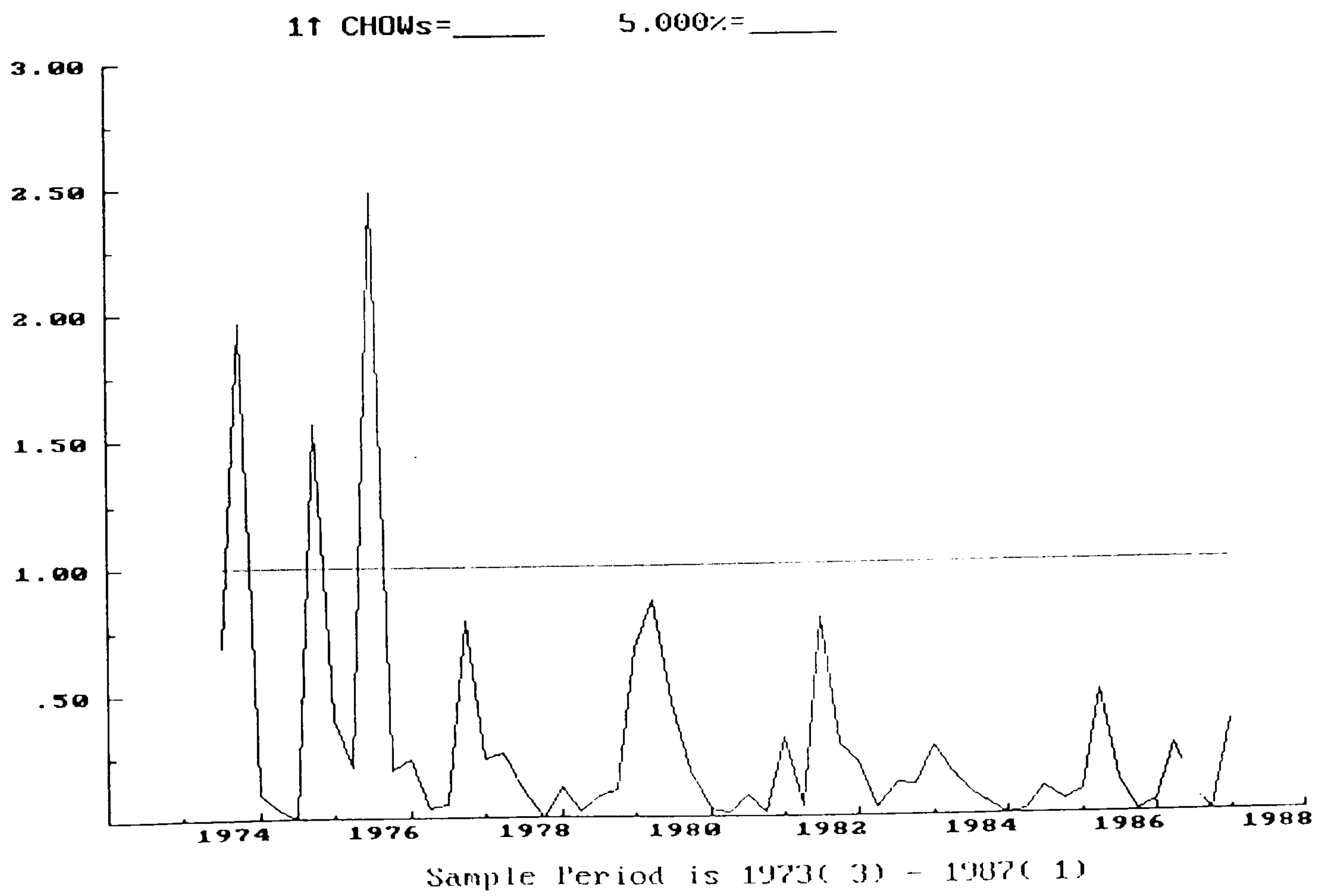
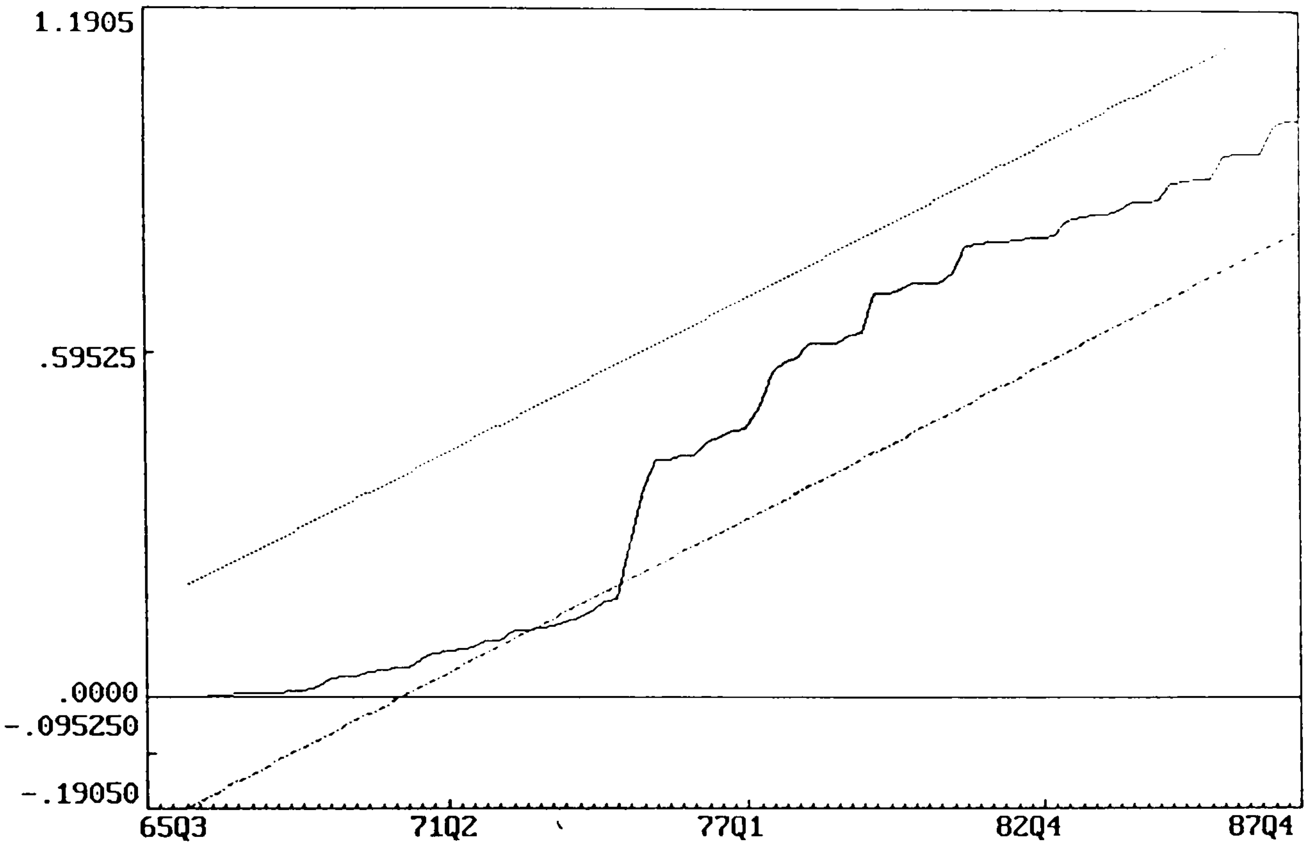


Figure 2.7.16 CUSUMSQ test for the regression of Δp on instruments



The straight lines represent critical bounds at 5% significance level

Figure 2.7.17 Actual and fitted values for the forward looking (FLRE) model

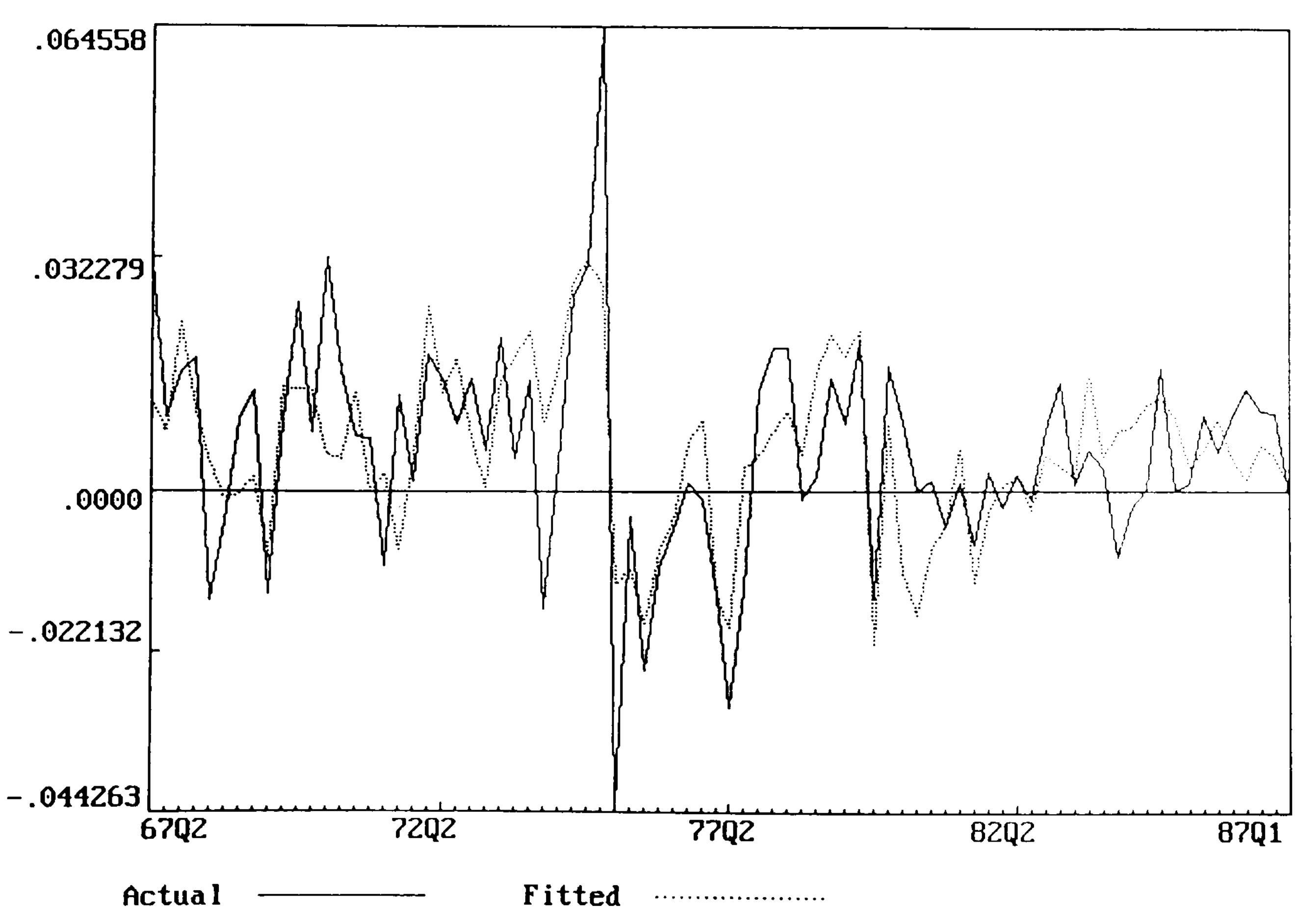
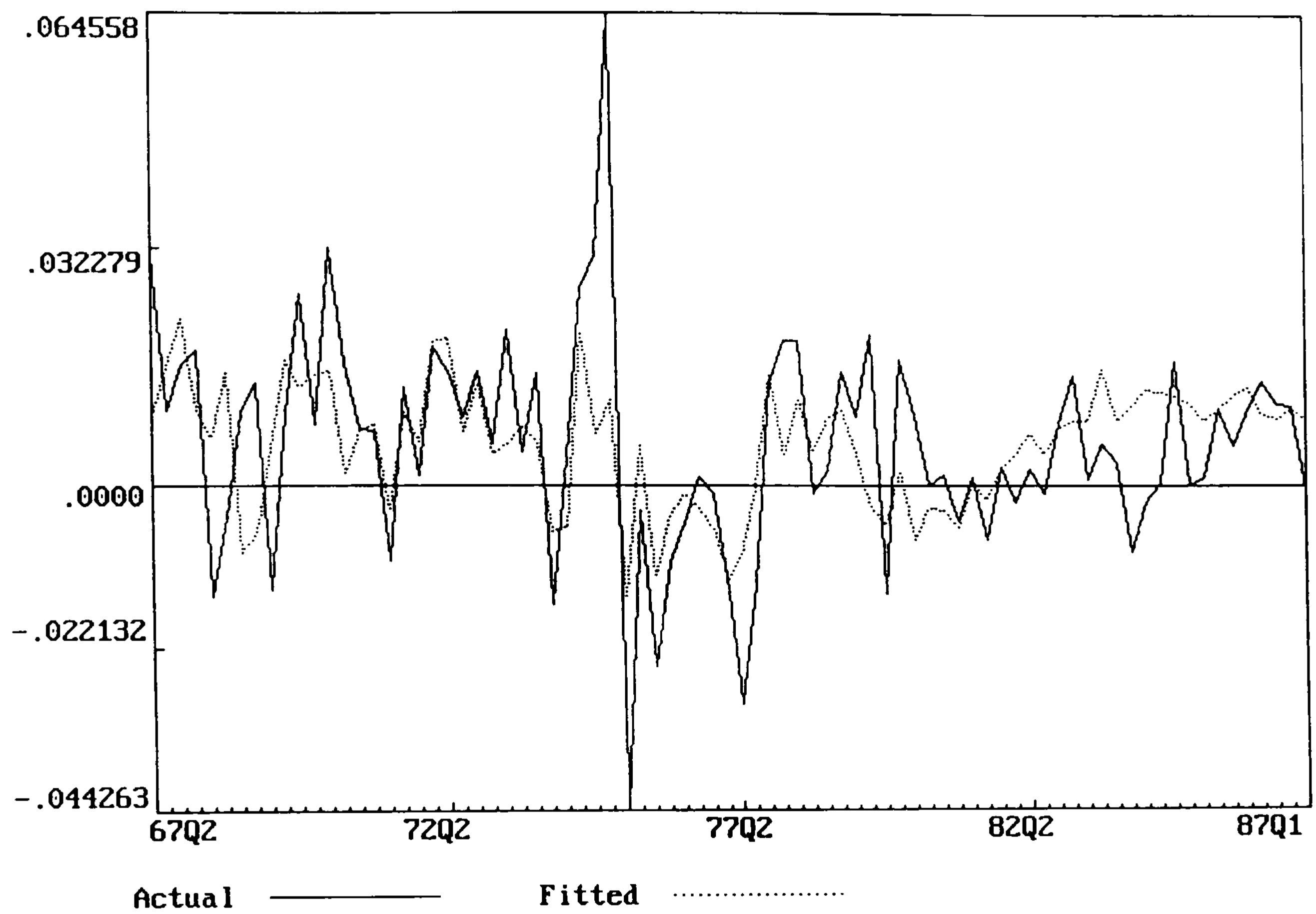


Figure 2.7.18 Actual and fitted values for the backward looking (BSLM) model



FOOTNOTES

1 Oswald (1982) reconciles the two models by assuming flat indifference curves for the union.

2 The results in tables 1,2,3, and 4 are obtained using Stephen Hall's Reg-X programme.

3 The Sargan-Bhargava test gives very clear cut results. None of the series are stationary but all the first differences are according to the DW statistics.

4 Once again we used REG.X developed by Stephen Hall to obtain our Johansen estimates. We use the maximum lag of 4 in our VAR system representing the quarterly frequency of our data.

5 We are grateful to Ray Barrell and Bahram Pesaran for this suggestion.

6 To test the robustness of this result we included four lags of every explanatory variable in the feedback model. The feedback model was still variance dominated by the forward looking model.

Appendix 2A.1

Data definition and Sources

All of the following variables were retrieved from the National Institute's Domestic Economic Model database, unless stated otherwise.

B replacement ratio, as in Layard and Nickell (1986).

CEX consumers' expenditure, £m. Economic Trends.

H average hours worked per operative in manufacturing (GB), index 1980=100. Economic Trends.

K capital stock, as in Layard and Nickell (1986)

MM an index of mismatch, as in Layard and Nickell (1986).

N employment total, UK, thousands. Department of Employment Gazette.

P_c consumer price index, 1980=100. Economic Trends.

PLU proportion of the unemployed who have been out of work for more than one year, as in Layard and Nickell (1986)

PM deflator, total imports, 1980=100. Economic Trends.

PNH price of new houses, 1980=100. Economic Trends.

PW wholesale price of manufactures, 1980=100. Monthly Digest of Statistics.

Π gross trading profits, non-oil company sector, £m. Economic Trends.

t_1 employment tax borne by the firm defined as (EC + NIS)/(IE - EC) where EC is employers' contributions; NIS is employers' national insurance surcharge and IE is income from employment. Transformed from Economic Trends.

t_2 income tax wedge, (TXPER + NIC - 0.5 x EC)/(IE -EC) where TXPER is tax of persons' income and NIC is national insurance contributions. EC and IE are as in t_1. Transformed from Economic Trends.

t_3 indirect tax rate, (AFC - NIS)/CE where AFC is adjustment to factor cost and CE is consumers' expenditure. NIS is as in t_1. Transformed from Economic Trends.

US short-term unemployment defined as U026/(N + U026) where U026 is the number of people, aged 18 or over, who have been unemployed for less than 26 weeks. Department of Employment Gazette. This series has been made consistent using Haskel (1990).

W average weekly earnings, £ per week. Economic Trends.

Y gross domestic product, output measure, 1980=100. Economic Trends.

APPENDIX A2.2

Unrestricted feedforward model- Instrumental Variable

$$\Delta(w-p_c(-1)) = \underset{(0.12)}{0.005} + \underset{(4.21)}{0.808}(\theta(L)+1-L)\Delta p + \underset{(1.73)}{0.180}\,\Delta(w-p_c)_{-2} +$$

$$-\underset{(3.32)}{0.489}\,\Delta(y-n-h)_{-1} + \underset{(0.01)}{0.005}\,\Delta mm - \underset{(4.07)}{0.309}\,(w-p_c)_{-1} + \underset{(1.50)}{0.134}\,t_{2,-1}$$

$$-\underset{(1.28)}{0.101}\,t_{3,-1} + \underset{(3.65)}{0.272}\,(y-n-h)_{-1} + \underset{(2.61)}{0.004}\,mm_{-1} - \underset{(0.80)}{0.006}\,us_{-1}$$

SEE=0.0116 DW=2.03

The unrestricted feedback model - OLS

$$\Delta(w-p_c(-1)) = \underset{(0.84)}{0.037} - \underset{(5.43)}{0.809}(\Delta p_{-1}-\Delta p_{-3}) + \underset{(2.24)}{0.228}\,(w-p_c(-1))_{-1}$$

$$-\underset{(3.09)}{0.458}\,\Delta(y-n-h)_{-1} - \underset{(4.71)}{0.386}\,(w-p_c)_{-1} + \underset{(1.13)}{0.101}t_{2,-1}$$

$$-\underset{(2.27)}{0.193}\,t_{3,-1} + \underset{(5.09)}{0.404}\,(y-n-h)_{-1} + \underset{(2.61)}{0.003}\,mm_{-1} - \underset{(2.74)}{0.022}\,us_{-1}$$

SEE=0.0019 DW=2.00

The unrestricted model with profits - OLS

$$\Delta(w-p_c(-1)) = \underset{(0.66)}{0.055} - \underset{(5.48)}{0.819}(\Delta p_{-1}-\Delta p_{-3}) + \underset{(3.55)}{0.297}\,(w-p_c(-1))_{-1}$$

$$\underset{(3.55)}{0.435}\,(w-p_c(-1))_{-2} - \underset{(3.10)}{0.473}\,\Delta(y-n-h)_{-1} - \underset{(4.91)}{0.450}\,(w-p_c)_{-1} + \underset{(1.76)}{0.160}\,t_{2,-1}$$

$$-\underset{(2.18)}{0.186}\,t_{3,-1} + \underset{(5.42)}{0.468}\,(y-n-h)_{-1} + \underset{(1.86)}{0.003}\,mm_{-1} - \underset{(2.90)}{0.025}\,us_{-1}$$

$$+\underset{(1.52)}{0.0186}\,(\pi-n)_{-6}$$

SEE=0.0119 DW=2.07

Chapter Three

Wages: The United Kingdom in a European Perspective

3.1 Introduction

In the previous chapter we noted that wage inflation has been a recurrent problem in the UK economy over the last two and a half decades. This is in sharp contrast to the experience of the German economy over the same period. Wage inflation in France too has been less erratic and volatile than in the UK.

To set the scene for our analysis, it is worth looking at a few labour market indicators in these three countries. The contrast between the experiences of France, Germany and the UK is illustrated in Table 3.1.1 which presents summary statistics for wage inflation, price inflation, unemployment and productivity in the UK, France and Germany during the period of our study.

Between 1966 and 1988 wage inflation, price inflation and the unemployment rate were on average higher and productivity lower in the United Kingdom than France and Germany. Some element of the higher productivity growth in France and Germany may be attributed to a catching up process during the post war reconstruction period. However, these indicators were also least stable in the United Kingdom: the standard deviation of wage inflation, price inflation and unemployment are highest in the United Kingdom between 1966 and 1988.

Table 3.1.1

Wage inflation, price inflation, unemployment rate and productivity growth in the UK, Germany and France 1966-88

Summary Statistics

per cent	Wage* inflation	Price* inflation	Unemploy. rate	Product.* growth
United Kingdom				
Means	11.01	6.43	11.37	2.4
Standard Dev.	5.16	4.57	3.51	1.7
Minimum	2.95	-2.58	3.85	-3.2
Maximum	30.82	19.46	18.17	5.8
West Germany				
Means	8.75	3.77	7.72	3.4
Standard Dev.	5.08	2.09	3.28	2.1
Minimum	1.88	-0.92	2.07	-1.3
Maximum	22.28	8.29	13.93	7.4
France				
Means	6.35	4.56	5.39	3.6
Standard Dev.	4.03	3.08	3.22	1.6
Minimum	2.03	0.70	1.10	0.4
Maximum	12.95	9.37	10.70	6.9

* increase in each quarter over the same quarter of the last year

Figures 3.1.1 and 3.1.2 depict the paths of wage and price inflation in the United Kingdom, Germany and France. Figure 3.1.3 presents the time path of the unemployment rate in the three countries. Between 1966 and 1973 France, Germany and the UK experienced comparable rises in wage inflation, price inflation and unemployment. However, the experiences of these three economies began to diverge after the first oil shock. Both price and wage inflation were kept in check in Germany: they never rose to more than 7 per cent after 1974. France exhibits a considerable degree of inertia; wage and price inflation remained high between 1974 and 1982 before falling sharply.

Following the oil price shock of the early 1970s and the breakdown of the 'social contract' in the UK, wage and price inflation soared to levels well above those suffered in the French and German economies. The subsequent incomes policy succeeded in bringing wage and price inflation down to the levels experienced in France by 1979. However, the wage and price explosion of 1979/80 was again more pronounced in the UK than in France and Germany.

All three countries experienced falling inflation as the recession of the early 1980s started to bite. However, when the economic recovery began in the mid-1980s, the UK again experienced disproportionate rises in prices and, in particular, wage inflation in comparison to France and Germany.

Turning to the unemployment statistics presented in Figure 3.1.3, we see that the UK, France and Germany have had very similar experiences. The first sharp rise in unemployment occurred in 1974, this was subsequent to the inflationary shocks of the early 1970s. The most dramatic rise in unemployment in the three countries started in 1980 and continued until 1986. A notable feature of Figure 3.1.3 is the persistence of unemployment in the three countries after each peak. Although unemployment exhibits a similar pattern in the three countries, the rise and fall of unemployment in the UK, particularly in the 1980s, has been more pronounced than France and Germany.

Table 3.1.2 illustrates another interesting aspect of the labour market in the three countries which would be fruitful to explore in a comparative framework. In 1989 Britain experienced a severe skill shortage problem in comparison to France and Germany. Could it be that Britain has suffered higher wage inflation as a consequence of this shortage?

Table 3.1.2

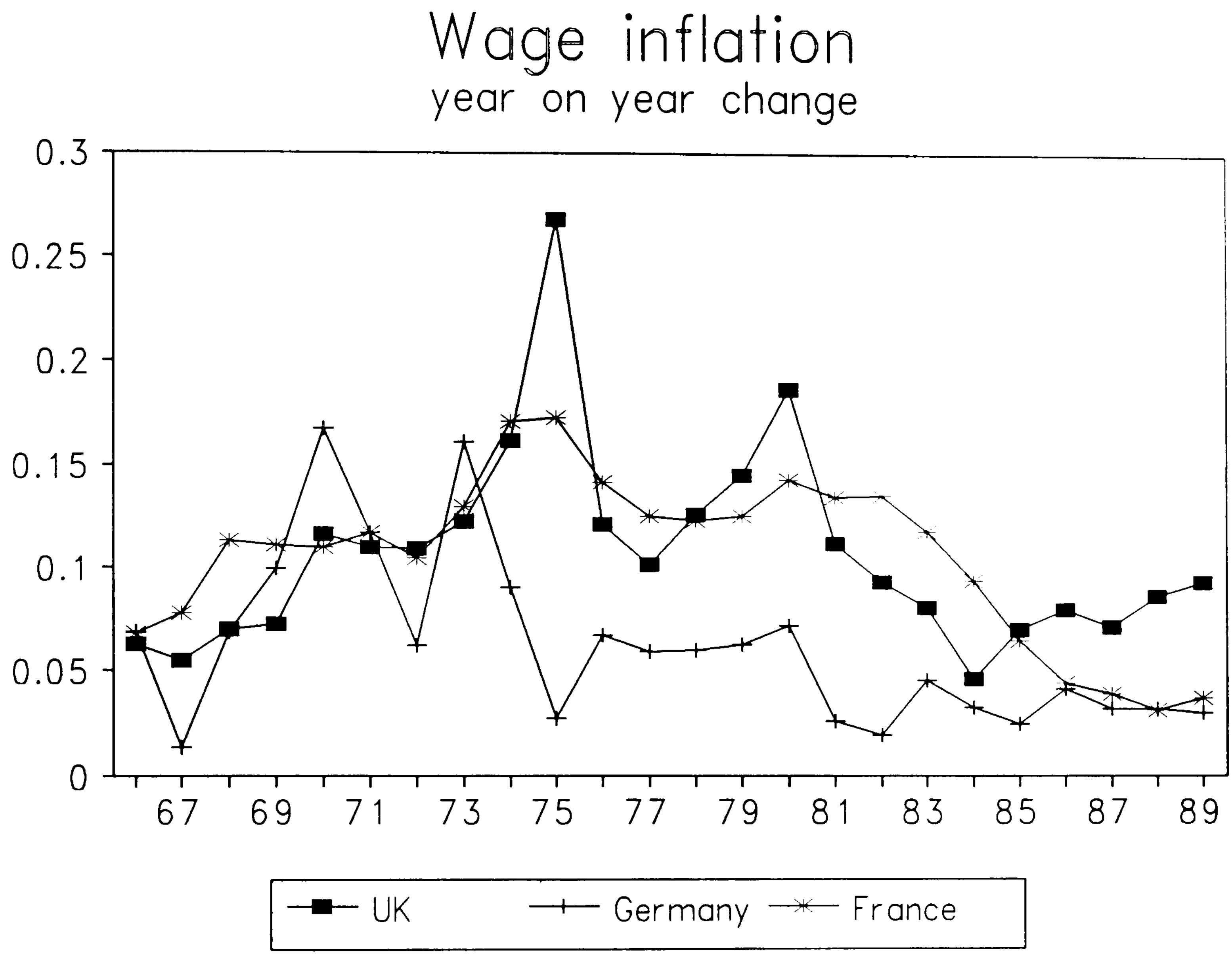
Proportion of firms whose output is constrained by a shortage of skilled labour (%)

Year	UK	France	Germany
1989	27	3	4

Source: European Community Business Survey

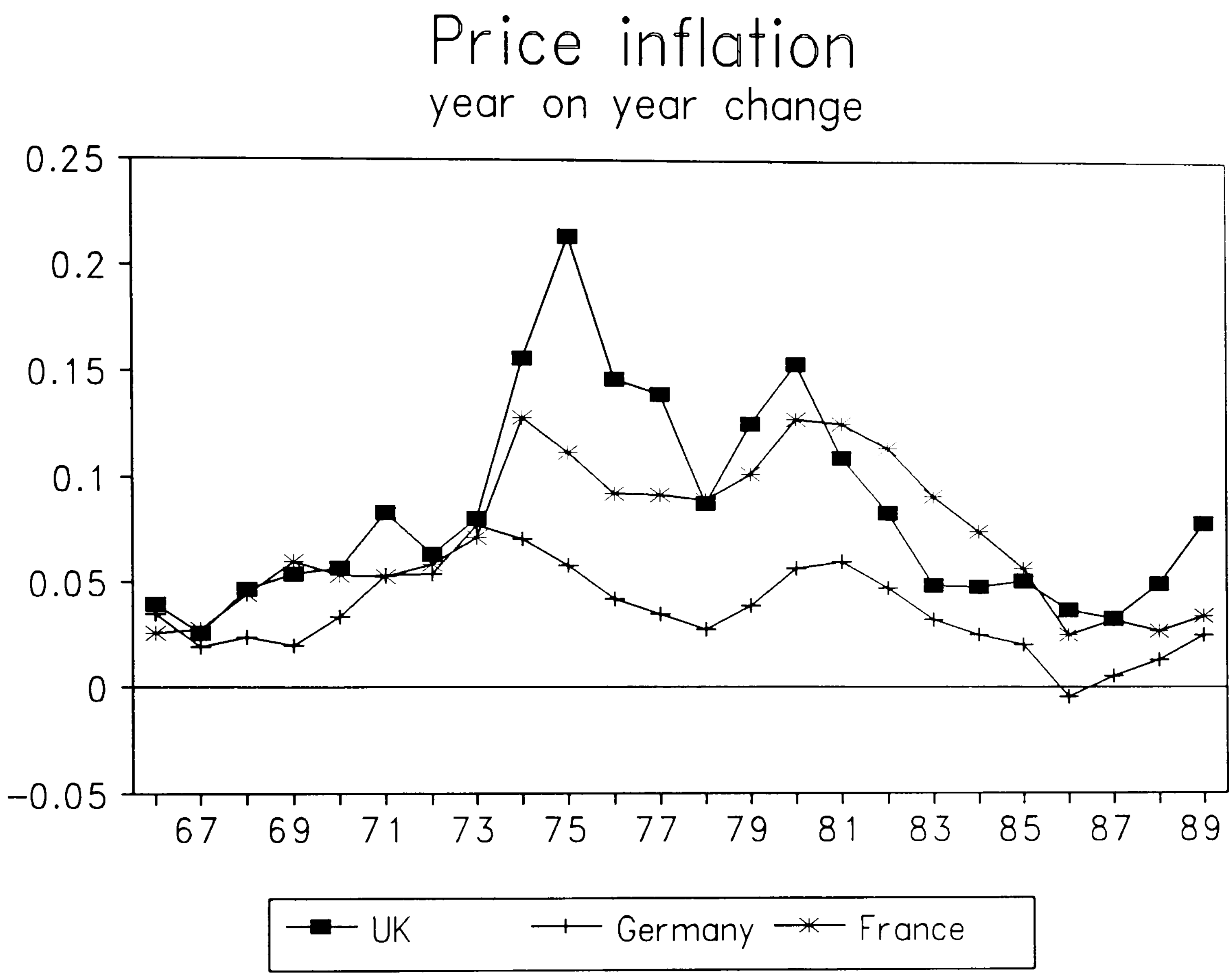
Our aim in this chapter is to compare wage determination in the UK with that in France and Germany with the aim of shedding some light on the cross-country differences. A multi-country study is not only attractive in itself because of the varied experiences and policy responses of the three countries but it also provides a potentially fruitful test of any economic hypothesis which may be considered to hold universally. For instance, we demonstrated in Chapter Two that long-term unemployment in the UK exerts no downward pressure on wage inflation. If we find the same to be true in France and Germany then this could well be a candidate for a universally accepted hypothesis. If on the other hand we find that long-term unemployment does have an influence on wages outside the UK, then we must explain why the UK is an isolated case.

Figure 3.1.1



Wage inflation
year on year change
0.3
0.25
0.2
0.15
0.1
0.05
0
67
69
71
73
75
77
79
81
83
85
87
89
UK
Germany
France

Figure 3.1.2



Price inflation
year on year change
0.25
0.2
0.15
0.1
0.05
0
-0.05
67
69
71
73
75
77
79
81
83
85
87
89
UK
Germany
France

Figure 3.1.3

Unemployment rate
Per cent
14
12
10
8
6
4
2
0
67
69
71
73
75
77
79
81
83
85
87
89
UK
Germany
France

3.2 Previous multi-country studies

During the 1980s most multi-country studies concentrated on explaining the varied unemployment experiences of the industrial economies. Earlier studies focused on the role of real and nominal wage rigidities in providing a constructive framework for highlighting cross-country differences.

Sachs (1979) and Branson and Rotemberg (1980) define real wage rigidity as the opposite of nominal wage rigidity. They focus on the amount of nominal inertia in the determination of nominal wages. Accordingly, long lags of past inflation in the wage equation indicate real wage flexibility because nominal wages are rigid.

Grubb, Jackman and Layard (1982) argue that real and nominal wage rigidities must, to some extent, explain unemployment and the above measures say nothing about how much unemployment will result from a given shock. They define real wage rigidity as the increase in the unemployment rate required to offset the long-run inflationary consequences of a real shock, where a real shock is one that leads to a different equilibrium real wages. Thus, real wage rigidity will be higher the less responsive nominal wages are to the unemployment rate. Coe (1985) builds on the above studies and defines real wage rigidity as the short-run elasticity of nominal wages with repect to inflation minus the short-run elasticity of nominal wages with respect to the unemployment rate so that real wage rigidity will be higher the more rapidly nominal wages respond to a price shock and the less responsive they are to the unemployment rate.

The above studies broadly confirm the conventional wisdom that real wages in North America and Japan are more flexible than in Europe, and that within Europe, Germany and Switzerland have the most flexible real wages.

Later studies focus on unemployment. Newell and Symons (1985) estimate a two equation model consisting of a real wage equation and a labour demand schedule applied to annual data for 16 OECD countries. This analysis is based upon and supportive of the market clearing approach. In particular, they find that across countries many variables which some theoretic models postulate, such as union power, mismatch, industrial conflicts, unemployment benefits and tax wedges, have no consistent impact on the product wage and that the labour supply schedule is inelastic in the long-run.

Newell and Symons characterise each country by the estimated values of the slope of the labour demand and supply schedules, i.e. employment lags in the demand schedule and wage lags in the supply equation. They conclude that most of the variation across countries is attributable to the slopes of the schedules and persistence in the employment equation. They sugggest that the economies with a less severe rise in unemployment have been those in which the supply equation is steep, where unemployment can exert downward pressure on wages.

Newell and Symons' finding that unemployment is a consequence of high real wages is in contrast with some country specific studies. For instance we mentioned in the last chapter that Layard and Nickell (1986) found that demand factors were of crucial importance in the rise of unemployment in the UK. For Germany, Franz and Konig's (1986) results suggest that demand factors loomed large in explaining the sharp rise of unemployment in Germany between 1980 and 1983. They also highlight the role of supply shocks such as the rise in material prices and the deterioration of the capital stock reinforced by the fall in investment. Franz and Konig (1986) also point out the impact of the rise in labour force participation on unemployment. In Germany between 1972 and 1982 the labour force grew by some 500,000. For France, Malinvaud (1986) illustrates that demand factors are important in influencing the demand for labour. He also rejects the hypothesis that wage inflexibility contributed to a fall in demand for labour in France. However, Malinvaud denotes two factors in explaining the sluggishness of the French wages. Firstly, he points to the indexation of wages to price inflation from the late 1960s to the early 1980s and secondly he emphasises the commitment to social cohesion by successive French governments.

We therefore have three country specific studies pointing to the importance of demand variables in determining the demand for labour. However, as we mentioned above this is not a universally accepted principle and well worth pursuing further in our econometric work.

A number of studies have highlighted the role of corporatism. Bruno and Sachs (1985) construct a measure of corporatism for 17 OECD countries and report partial correlation between their index and inflation minus growth. They conclude that corporate economies are better able to absorb supply shocks.

Bean, Layard and Nickell (1986) estimate wage and employment equations for 19 OECD countries based on the imperfect competition model. They discover that there is a downward sloping demand schedule for all countries but the US. They find that aggregate demand has a significant positive effect except for Australia, Japan and Sweden and that the wage equation has the correct slope for all countries except Italy and the US. Furthermore, they relate variations across country estimates to the Bruno and Sachs ranking. They associate corporatism with the short and long-run slopes of the wage equation, i.e. the speed of adjustment in the wage and employment equation, and observe unemployment. They conclude that there is support for the notion that structural differences in the labour market can be related to institutional characteristics, and that the labour market in corporate economies adjusts more quickly.

Calmfors and Driffill (1988) draw attention to a different aspect of corporatism. They focus on the degree of centralisation of wage bargaining. They argue that the extremes of centralized wage bargaining work best. Accordingly, they provide some empirical evidence to demonstrate that the more successful economies are either highly centralized in their wage bargaining, such as the Nordic countries, or else highly decentralized such as the US and Japan

Given that the lack of time series data on institutional characteristics is a major drawback in any multi-country study, the corporatism approach has the attraction of incorporating country specific attributes. However, this approach suffers from the problem of time-invariance and measures of corporatism remain a subjective measure. For instance, Calmfors and Driffill consider Switzerland (ranked 15 out of 17) to be nearly as decentralized as the US (ranked 16) while Bruno and Sachs consider it to be as corporatist as Sweden or Norway (both ranked 4 out of 17).

Nickell (1990) estimates a system consisting of a real wage equation and a price equation. The estimated two equation system can be solved to obtain an unemployment equation. He finds that real wage rigidity is very low in Japan and the European Free Trade Association, which includes Austria, Switzerland and the Nordic countries, and high among the European Community countries. An interesting finding of this paper is that hysteresis is a very common phenomenon, only being absent in Japan, the US and Switzerland. However, with the exeption of the UK, it tends to be a feature of price setting rather than wage determination as it often appears in the price equation and not in the wage equation. This finding indicates that outside the UK "the sluggish adjustment of factors is more important in determinimg persistence than insider-outsider or long-term unemployment effects in wage determination". Later in this chapter we shall return to this point and attempt to discover why the UK is an isolated case.

3.3 Theoretical framework

In Chapter Two we estimated a dynamic wage equation for the United Kingdom and presented a forward looking model as well as a feedback one. We also illustrated that both versions of the model were fairly robust, although the forward looking model performed slightly better.

In Chapter One we noted that most theoretical models of wage determination implied the joint determination of wages and employment. However, in Chapter Two we did not attempt to close our model by estimating a labour demand schedule together with our wage equation. This we intend to remedy in the current chapter.

Our long-run wage equation of the last chapter included productivity measured as output per man-hour, direct and indirect tax wedges, short-term unemployment rate and a measure of mismatch. Employment appeared in the long-run wage equation as a constituent of the productivity variable. Given the joint determination of wages and employment and hence the endogeneity of productivity in a wage equation, in the current chapter we shall estimate a wage-productivity system. This approach also has the added advantage of making our analysis in this chapter easily comparable with that of Chapter Two.

In Chapter Two we examined the determinants of wages, but, what are the determinants of employment and hence productivity? In Chapter One we pointed out that there is little theoretical disagreement when it comes to the determinants of wages. Nickell (1982) illustrates that both the right-to-manage model and the efficient bargaining model imply a wage equation with identical comparative statics. However, this unanimity disappears when it comes to the employment equation.

In Chapter One we observed that according to the right-to-manage model, the union and the employer bargain over wages and then the employer sets the level of employment. Hence, variables which affect the level of wages only influence employment through their impact on wages. Any variable which enters the wage equation must be insignificant in a regression of employment on wages unless it shifts the labour demand curve. However, in the efficient bargaining framework, where bargaining takes place over both the level of employment and wages, any variable entering the wage equation may also affect employment. In the efficiency wages model employment is determined by the real wage and the fall back wage together with any other variables influencing the 'effort' of the workers.

A good starting point for deriving a productivity equation is the market clearing labour demand equation, (1.2.7), which we derived in Chapter One, section 1.2:

$$n = \alpha_0 - \alpha_1(w+t_1-p_f) - \alpha_2(p_m-p_f) + \alpha_3 k \qquad (3.3.1)$$

where n is log of employment, w log of money wages, t_1 is the employers' tax wedge, p_f is log of output prices, p_m log of material prices and k log of capital stock. We also note that α_1, α_2 and α_3 are all positive.

If we move away from the market clearing model towards an imperfectly competitive model then we can postulate that the demand for labour is also dependent on the aggregate demand in the whole economy:

$$n = \alpha_0 - \alpha_1(w+t_1-p_f) - \alpha_2(p_m-p_f) + \alpha_3 k + \alpha_4\sigma \qquad (3.3.2)$$

where σ is a measure of aggregate demand relative to the potential output and $\alpha_4>0$. We shall explore the role of σ further in our empirical work.

Layard and Nickell (1985 and 1986) show that (3.3.2) can also be derived by combining a production function and a price equation. In particular, they show that under the assumption of constant returns to scale the coefficient on the capital stock, α_3, is unity in the long-run. In this case, we can take k to the left hand side and derive the following productivity equation in terms of the capital labour ratio:

$$k-n = -\alpha_0 + \alpha_1(w+t_1-p_f) + \alpha_2(p_m-p_f) - \alpha_4\sigma \qquad (3.3.3)$$

However, the available capital stock data are often very poor. For this reason, in deriving the wage equation of Chapter Two we substituted out capital stock from the wage equation. Capital stock is difficult to measure and there are often no satisfactory time series: the available data is usually derived from stock-building series with a constant depreciation rate. We can also substitute out k from the (3.3.3) using a production function of the form $y-n = \gamma_0 + \gamma_1(k-n)$, to obtain:

$$y-n = \beta_0 + \beta_1(w+t_1-p_f) + \beta_2(p_m-p_f) - \beta_4\sigma \qquad (3.3.4)$$

(3.3.4) together with the wage equation of the last chapter provide us with opportunity of estimating a long-run system. In this framework where the labour demand and the productivity equations are closely related in the long-run, (3.3.4) determines the level of employment for any given level of output, y.

The labour demand in (3.3.2) is consistent with the right-to-manage model. However, under an efficient bargaining regime, we could include all the determinants of wages on the right hand side of (3.3.2) and hence in the productivity equation (3.3.4). In an efficiency wages framework we would also have to include a measure of fall back wages.

3.4 Econometric methodology

In the previous section as well as in Chapter One we emphasised that from a theoretical point of view wages and employment and hence wages and productivity are jointly determined. From an econometric point of view this calls for a system estimation of our wage-productivity model. In a recent paper Hendry and Mizon (1989) re-examine the methodology for estimating econometric models. They argue that in addition to a sound theoretical basis there are three necessary conditions for any econometric model to be cogent. These are: (i) parameter constancy and structural stability, (ii) weak exogeneity of the un-modelled variables and finally (iii) "parsimonious encompassing of the associated unrestricted system".

We made extensive use of the first criterion in Chapter Two when examining the forward looking and feedback dynamic models of wages.

Formally, weak exogeneity can be defined as follows. Suppose we intend to make inferences about a sub-vector θ_1 of the parameters of the data generating process $x_t=(y_t, z_t)$. Let us denote the remaining parameters as θ_2. If we choose y_t as the smallest set of variables for which it is possible to write the conditional density as :

$$D(y_t, z_t | Y_{t-1}, Z_{t-1}; \theta_1, \theta_2) = D(y_t | z_t, Y_{t-1}, Z_{t-1}; \theta_1) \\ .D(z_t | Y_{t-1}, Z_{t-1}; \theta_2) \qquad (3.4.1)$$

where $Y_{t-1}=(y_1, y_2, \ldots, y_{t-1})$ and $Z_{t-1}=(z_1, z_2, \ldots, z_{t-1})$. Then, z_t is weakly exogenous for the parameter θ_1. We can make inferences about θ_1 by examining the conditional density of y_t taking z_t as given. Strong exogeneity would require y_t not to Granger cause z_t.

The question we have to address now is how to test for weak exogeneity. Hendry and Mizon (1989) point out that the Johansen maximum likelihood technique, which we employed in Chapter Two, can not only be used to discover the number of cointegrating vectors in any data set and to estimate each one, but it also can be deployed to establish weak exogeneity.

Consider the VAR model which we discussed in Chapter Two, section 2.4:

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \Gamma_{k-1} \Delta X_{t-k+1} + \Pi X_{t-k} + \mu + e_t \qquad (t=1,\ldots,T) \qquad (3.4.2)$$

where X_t is a vector of p variables, $e_1,\ldots,e_T$ are $IIN_p(o,\Lambda)$, $X_{-k+1},\ldots,X_o$ are fixed and μ is an intercept vector.

Π is the cointegrating matrix containing information about the long-run relationships between the variables in the data vector. We noted in section 2.2.4 that when Π has rank r, $0<r<p$, it can be decomposed into two distinct (pxr) matrices α and β such $\Pi=\alpha\beta'$. In this case the parameters of the cointegrating vectors are contained in the β matrix. In section 2.2.4 we discussed Johansen's procedure for identifying and estimating these cointegrating vectors.

The key to weak exogeneity lies in the α matrix. According to Johansen, the α matrix provides the weights with which the cointegrating vectors enter the equations of the system. Hendry and Mizon (1989) illustrate that the elements of the α matrix also provide a clue to weak exogeneity. For example, consider a wage-productivity system: we would expect the α matrix to indicate a high weight for the level wage entering the dynamic equation for wages; if the weight for productivity entering the dynamic equation for wages is also large, this indicates that productivity cannot be considered weakly exogenous in determining wages. The correct modelling procedure would then be to estimate a wage-productivity model using system estimation techniques such as Three Stage Least Squares (3SLS) or Full Information Maximum Likelihood (FIML).

Let us now turn to the third condition for cogency of an economic model, namely "parsimonious encompassing of the associated unrestricted system". The focus of Hendry and Mizon (1989) is on establishing a methodology for testing the validity of any linear dynamic structural econometric model (SEM). They illustrate that testing whether a SEM is a valid reduction of its associated VAR is a powerful way of evaluating whether a model is congruent with the available data.

Suppose our structural model has the form:

$$\Phi X_t = u_t \qquad (3.4.3)$$

where Φ is a (nxp) matrix of structural parameters with $n \leqslant p$. Let us re-write (3.4.2) as

$$X_t = \Pi^* X_{t-1} + e_t \qquad (3.4.4)$$

where Π^* is suitably chosen to equate (3.4.4) with (3.4.2).

Multiplying (3.4.4) by matrix Φ we obtain:

$$\Phi X_t = \Phi\Pi^* X_{t-1} + \Phi e_t = u_t. \qquad (3.4.5)$$

Now, u_t will be serially uncorrelated only if

$$\Phi\Pi^* = 0 \qquad (3.4.6)$$

so that $u_t = \Phi e_t$.

Hendry and Mizon argue that (3.4.6) cannot be assumed to hold, it has to be tested relative to the associated VAR in (3.4.4). The VAR can be estimated in its own right as a congruent representation of the data. Hendry and Mizon demonstrate that "encompassing the associated

VAR" is a necessary condition for the cogency of any structural model. Furthermore, they show that (3.4.6) is a sufficient condition for the structural model (3.4.3) to encompass its congruent VAR (3.4.4). This condition also happens to be equivalent to the conventional condition for the validity of over-identifying restrictions and can be tested by simply using a likelihood ratio test. The VAR itself has to be estimated carefully, ensuring parameter constancy and structural stability. Our third criterion for successful model building is therefore condition (3.4.6).

3.5 Empirical results

In this section we present estimates of wage-productivity systems for the UK, France and Germany. We shall focus on the British estimates, but those of France and Germany provide instructive comparisons.

In Chapter Two we applied the Johansen maximum likelihood procedure to estimate all the cointegrating vectors in a data set consisting of real wages, productivity, the short term unemployment rate, direct and indirect tax wedges and mismatch. Although we were able to unravel two cointegrating vectors, only one of them was consistent with economic theory. We recognised this cointegrating vector as a wage equation. The other cointegrating vector did not yield an immediate economic interpretation. We argued at the time that this vector could have been an incomplete productivity equation. If so, we would have then had a complete wage-productivity system since we illustrated in our theoretical section above that a labour demand schedule can be written in the form of a productivity equation in the long-run.

In our theoretical derivation of the wage equation in Section 2.2 above, we substituted out the capital-labour ratio. Including this trended variable in our estimating system may enable us to identify the productivity equation since capital is a determinant of output.

Table 3.5.2 provides Johansen's maximum likelihood estimates of all the eigenvectors together with the corresponding eigenvalues when the capital-labour ratio is included in our set of variables. Table 3.5.1 shows the likelihood ratio tests demonstrating that there are at most r cointegrating vectors in this data set with seven variables. The third column in Table 3.5.2 presents additional test statistics proposed in Johansen and Juselius (1990). This is a test of the null hypothesis that there are at most r cointegrating vectors against the alternative hypothesis that there are r+1. Unfortunately, Johansen and Juselius do not provide critical values beyond r=5. Although Hall (1988) provides critical values up to r=10, these are derived without allowing for a constant. However, judging from Johansen and Juselius (1990) for $r \leqslant 5$, the critical values with and without a constant are not far apart. Judging by the critical values in Hall (1988) and Johansen and Juselius (1990), there are at least two cointegrating vectors present in our set of variables.

Table 3.5.1

Likelihood ratio tests*

	$-T\Sigma\ln(1-\lambda)$ Max r	$-T\ln(1-\lambda_r)$ r vs (r+1)
0	205.6	66.6
1	139.0	47.6
2	91.4	36.7
3	54.6	24.3
4	30.4	15.3
5	15.1	14.3
6	1.0	1.0

*This table and all the others reported in this section have been estimated using PC-GIVE and PC-FIML.

Table 3.5.2

Johansen's maximum likelihood estimates (1967Q1-1987Q4)

Eigenvalue	$w-p_c$	y-n-h	t_2	t_3	us	mm	k-n-h
0.565	0.71	-1	-0.25	0.70	0.03	-0.03	0.66
0.486	-1	1.06	0.40	-0.56	-0.09	0.01	0.20

The exact definitions of the data are given in Appendix A3.1. We have only reported the two cointegrating vectors in Table 3.5.2 and normalised the first vector about productivity and the second vector about wages.

The second vector in Table 3.5.2 bears great resemblence to the long-run Johansen and OLS wage equations which we estimated in section 2.5 of Chapter Two. The only additional variable is the capital-labour ratio which has the correct sign. All the other coefficients have the correct sign and magnitude for this to be a wage equation. Given that we discussed the wage equation extensively in the last chapter, we shall not dwell upon this equation much further but focus our attention on the first cointegrating equation.

One interesting feature of the first cointegrating vector which persuades us to think that this is a productivity equation, is the magnitude of the long-run coefficients on the real wage and the indirect tax wedge. Looking back at equations (3.3.2) and (3.3.4) we see that the correct measure of real wage in the labour demand and hence productivity schedule is the nominal wage deflated by the output price index. In Table 3.5.2 our real wage variable has been deflated by the consumer price index. We know that

$$w-p_f = (w-p_c)+(p_c-p_f) = w-p_c + t_3 \quad \text{since } p_c-p_f = t_3 \qquad (3.5.1)$$

where w is the log of nominal wages, p_f is the log of the output price index, p_c is the log of the consumer price index and t_3 is the indirect tax wedge. Therefore, we expect the real wage, $w-p_c$, and the indirect tax wedge, t_3, to appear with the same sign and equal magnitudes in the productivity equation. This is indeed the case as the coefficient of the real wage is 0.71 and that of the indirect tax wedge is 0.70.

The long-run wage elasticity is -0.71, however, this is not strictly the long-run wage elasticity of labour demand since we have y-n-h on the left hand side as well as the capital-labour ratio on the right hand side.

In the right-to-manage model we would not expect any of the other variables appearing in the wage equation to be significant in the labour demand schedule and hence in the productivity equation, unless we have reasons to believe that they shift the labour demand schedule. However, in Table 3.5.2 we have no measure of the significance of each variable. The Johansen technique does provide a procedure to test for the significance of a variable in the system, any restrictions can be tested across the whole system rather than in any one equation. One method for testing whether other variables apart from the real wage and indirect taxes are significant in the productivity equation is to estimate an unrestricted dynamic model for the first cointegrating vector. We shall pursue this method later in this section. Let us turn to the α matrix which is provided in Table 3.5.3.

Table 3.5.3

The adjustment coefficients from the α matrix

Equation	$w-p_c$	y-n-h	t_2	t_3	us	mm	k-n-h
y-n-h	0.064	-0.030	-0.006	0.004	-0.003	-0.001	0.036
$w-p_c$	**-0.318**	-0.043	-0.179	0.007	0.008	0.000	-0.086

The most interesting feature of the adjustment matrix, α, is that it implies that the main effect of the second cointegrating vector is on $w-p_c$. This removes any doubts that the second cointegrating vector is a long-run wage equation. Interestingly, the second cointegrating vector has a negligible effect on each of the other variables in the model indicating that these other variables may be considered weakly exogenous in estimating the dynamic model for the real wage. This indicates that the estimation of the dynamic wage equation on its own in the last chapter was not incorrect.

The adjustment coefficients for the first cointegrating vector show that productivity affects the dynamic equations for the real wage as well as the dynamic equations for productivity and the capital-labour ratio. Specifically, wages may not be considered weakly exogenous in estimating a dynamic model of productivity. There are enough interesting features in this long-run system to encourage us to pursue it further and estimate the dynamic model.

In estimating the dynamic structural system, we adhere to the criteria of model selection advocated by Hendry and Mizon (1989) which we briefly discussed in Section 3.4. In particular, if we believe that wages and productivity are simultaneously determined, then we have to use system estimation techniques such as 3SLS or FIML to estimate a dynamic wage equation jointly with a productivity equation. However, we also learned above that a valid structural econometric model must encompass its congruent VAR. Hence, our first step is to formulate a data congruent wage/productivity VAR before proceeding to estimate a dynamic structural model and test for encompassing.

We tested for the relevance of the lagged values in a two equation unrestricted VAR with $\Delta(w-p_c(-1))$ and $\Delta(y-n-h)$ as the dependent variables, before retaining a simplified version which included $\Delta(w-p_c(-1))$, $\Delta(w-p_c(-1))_{-1}$, $\Delta(w-p_c(-1))_{-2}$, $\Delta(y-n-h)_{-1}$, $\Delta(y-n-h)_{-2}$, Δ^2p_{-1}, Δ^2p_{-2}, Δ^2p_{-3}, Δmm, Δmm_{-1}, Δus_{-1}, $r1_{-1}$ and $r2_{-1}$. The last two terms are the residuals from the second and the first cointegrating vectors respectively and the Δ indicates the difference operator. Note that to make the comparison with the last chapter easy we have deflated the dynamic term in wages by lagged prices. This also has the added advantage of removing the need to estimate a separate price equation in our VAR. Besides, as we illustrated in Chapter Two, the dynamic properties of a purely feedback model are fairly similar to a forward looking model with current and future prices.

Table 3.5.4 gives the F-tests for the significance of each regressor in the simplified VAR; this tests the overall significance of the variables across both dynamic equations. Table 3.5.5 presents the χ^2-tests for the VAR residuals to be normally distributed and finally Figures 3.5.1 and 3.5.2 record the sequence of scaled 'break point' Chow statistics testing for the constancy of the coefficients in each equation. Hendry and Mizon argue that this is a convenient way of checking parameter stability of the VAR instead of looking at the constancy of all the recursively estimated coefficients.

Table 3.5.4

F-tests on the VAR regressors

$\Delta(w-p_c(-1))_{-1}$	$\Delta(w-p_c(-1))_{-2}$	$\Delta(w-p_c(-1))_{-2}$	$\Delta(y-n-h)_{-1}$	$\Delta(y-n-h)_{-2}$
1.59	6.51	0.93	6.65	1.24

Δ^2p_{-1}	Δ^2p_{-2}	Δ^2p_{-3}	Δmm	Δmm_{-1}	Δus_{-1}	$r1_{-1}$	$r2_{-1}$
6.59	8.01	9.85	0.13	0.51	3.98	3.44	2.52

Judging by the results of Tables 3.5.5 and Figures 3.5.1 and 3.5.2, the VAR has constant coefficients and normally distributed errors. Therefore, the VAR appears to be congruent with the data and we can now turn to estimating our structural model and test for encompassing. Our dynamic wage equations presented in Chapter Two form the starting point for formulating a structural model. The structural model estimated by FIML is is presented in Table 3.5.6.

Table 3.5.5

<u>**χ^2-test for normality**</u>

	$\Delta(w-p_c(-1))$	$\Delta(y-n-h)$
$\chi^2(2)$	2.42	3.9

Figure 3.5.1 Scaled 'Break Point' Chow Tests for $(w-p_c)$

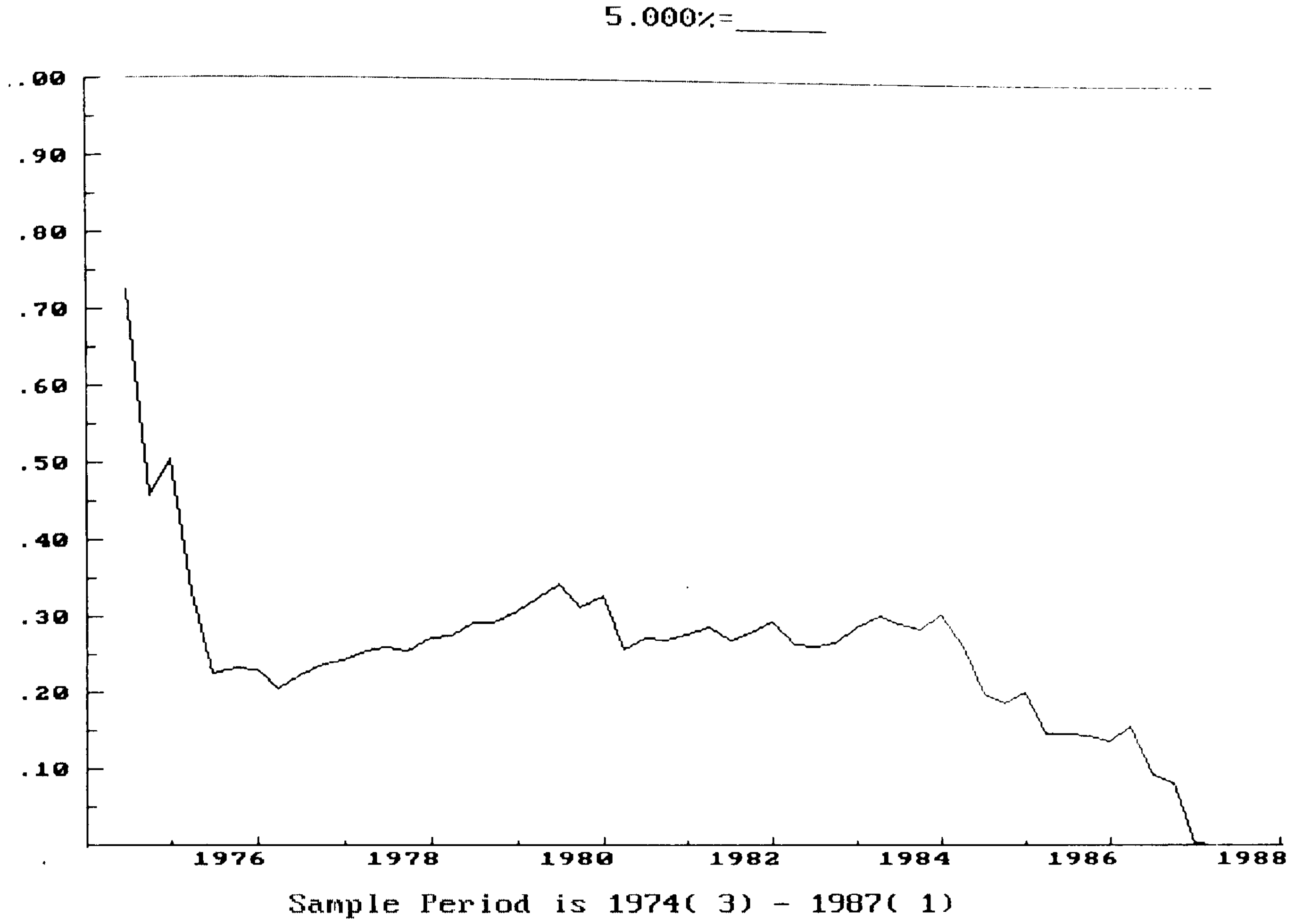


Figure 3.5.2 Scaled 'Break Point' Chow Tests for (y-n-h)

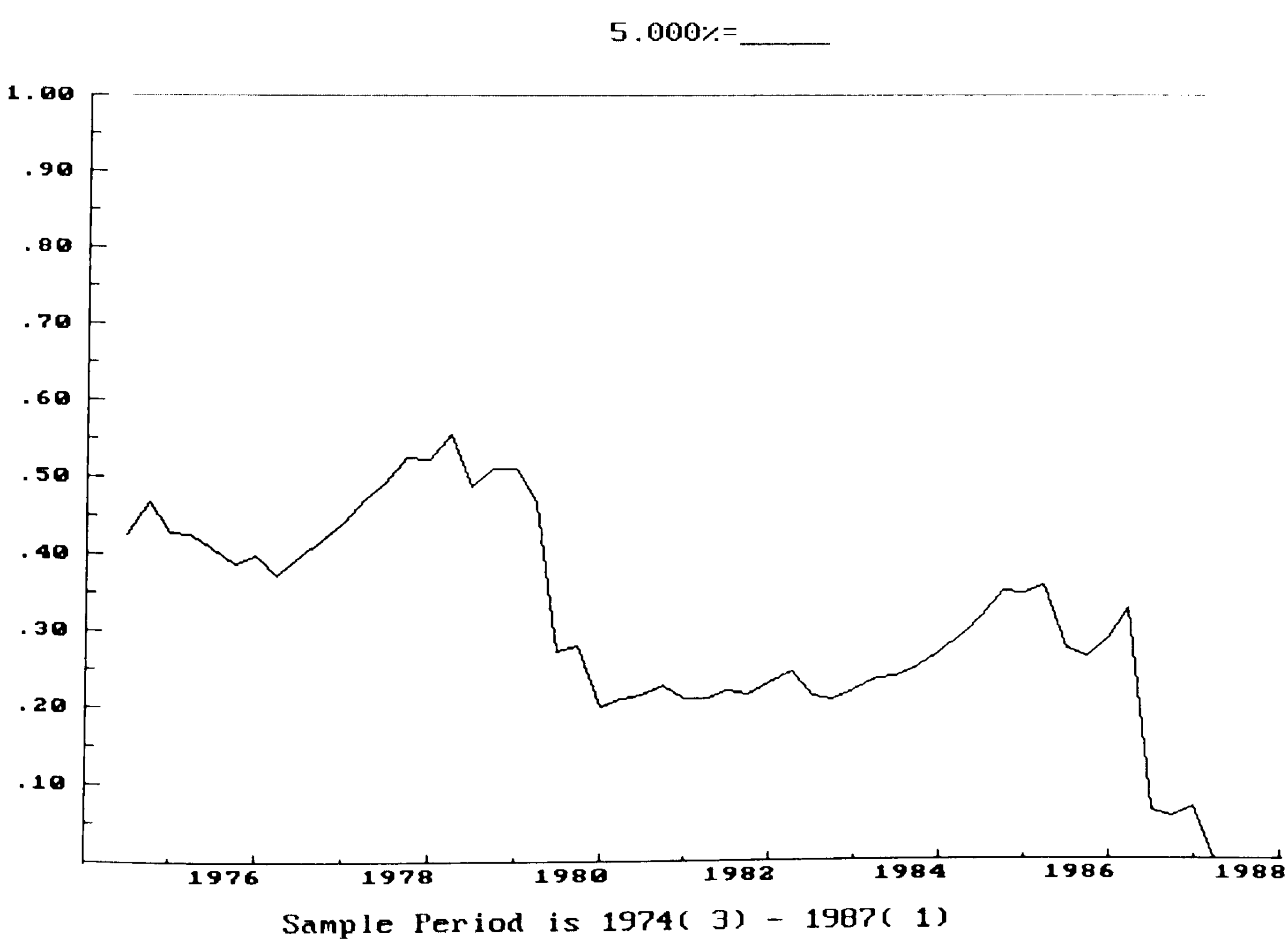


Table 3.5.6

FIML estimation of the wage-productivity system in the UK

$$\Delta(w-p_c(-1)) = \underset{(4.33)}{0.003} + \underset{(3.24)}{0.309}\Delta(w-p_c(-1))_{-1} + \underset{(4.50)}{0.421}\Delta(w-p_c(-1))_{-2}$$
$$- \underset{(3.28)}{0.403}\Delta(y-n-h)_{-1} - \underset{(4.71)}{0.815}\Delta^2 p_{-1} - \underset{(4.32)}{0.712}\Delta^2 p_{-2} - \underset{(5.54)}{0.452} r1_{-1}$$

SEE = 0.018

$$\Delta(y-n-h) = \underset{(2.63)}{0.002} - \underset{(2.05)}{0.187}\Delta(y-n-h)_{-1} + \underset{(3.41)}{0.43}\Delta(w-p_f(-1)) - \underset{(2.24)}{0.238}\Delta^2 p_{-1}$$
$$- \underset{(3.90)}{0.218} r2_{-1}$$

SEE = 0.008

The first notable feature of the FIML estimates of the structural model is the remarkable robustness of the results we presented in Chapter Two. The FIML estimates are remarkably like those we obtained in Table 2.7.2 when we estimated the feedback model of wages by OLS. This is not surprising since the wage equation has no contemporaneous variables in productivity. However, the productivity equation does have change in current wages as a regressor. We shall see later that in France and Germany the FIML estimation is essential since current changes in wage and productivity appear in both equations of the system. The crucial question is: does the structural model encompass the VAR? The χ^2-test of the overidentifying restrictions based on (3.4.6) is

$$\chi^2(15)=10.53.$$

Our model is, therefore, a very satisfactory one from the point of view of applied econometrics as it meets all the criteria that we set out in Section 3.4 above. However, before we proceed to provide estimates for France and Germany and compare our results, we have to ask ourselves if the econometric model presented above is a convincing one from a theoretical point of view. In spite of the econometric cogency of the findings there are a few features that require further investigation.

Looking back on the theoretical models of labour demand in (3.3.2) and productivity in (3.3.4) we see that the employer tax wedge and a measure of demand appear in these equations. None of these two measures is included in the long-run vector for productivity. The necessity of including an employer tax wedge is clear from the theory, the wage which the employer has to pay is $w+t_1-p_f$. However, one may argue that there is no role for a demand measure in a long-run labour demand schedule. In particular, if the labour demand schedule is represented by a productivity equation, one may argue that in the long-run both employment (or employment hours) and output are equally affected by demand, leaving no role for a specific demand measure in a productivity equation. On the other hand, it is possible to conceive of situations in which output and employment (or employment hours) are not affected in the same manner by changes in demand. Firstly, they may not be affected in the same proportions. Secondly, if the economy is faced with buoyant demand, total employment hours may not increase until economic expansion is well underway. Economic recovery, following the recession of 1980/81, began in 1982, although total employment hours only started to increase sharply in 1985. Finally, Table 2.1.2 in Chapter Two indicates that productivity increases have been higher, on average, during periods of economic boom. From a purely econometric point view, if the demand variable is integrated of order one, I(1), or higher then it would have to be included in the long-run equation.

The question of whether or not demand should appear in the productivity or labour demand schedule can be settled empirically.

The cointegrating vector in Table 3.5.2 includes direct taxes, the unemployment rate and mismatch; these variables do not yield an immediate economic interpretation, although, they can be justified by an appeal to the efficient bargaining model. The Johansen procedure does not provide us with significance levels and any hypothesis has to be tested across both the estimated coefficients. To test whether direct taxes, the unemployment rate and mismatch should appear in the productivity equation, we estimated the unrestricted version of the dynamic productivity equation of Table 3.5.6. This involves including the individual variables of the cointegrating vector into the dynamic equation instead of the lagged residual from the long-run vector. We then carried out a F-test for the joint significance of t_2, us and mm. The F-statistic ($F_{3,68}=1.07$, $F_{critical}=2.75$) indicates that they are not jointly significant.

Therefore, there are grounds for exploring alternative specifications of the productivity equation. One such method of estimation would be to directly estimate (3.3.4) by Johansen before proceeding to formulate a structural wage-productivity system to be tested against its congruent VAR. For this we need a measure of demand. The European Community Business Survey (ECBS) provides the results of quarterly surveys of British, French and German firms. Exactly the same questionnaire is sent to firms in the three countries. One of the questions asks the firms whether their output is constrained by lack of demand or orders for their products. The ECBS provides a time series of the proportion of firms whose output is constrained in this manner. We include this variable as a measure of demand or rather demand constraint, noted DC (or dc if logged), in the analysis below. One must bear in mind that as demand falls, dc rises and vice-versa.

Table 3.5.8 reports the Johansen maximum likelihood estimates of all the eigenvectors when equation (3.3.4) is directly estimated. The likelihood ratio tests in Table 3.5.7 demonstrate that there is one, and only one, cointegrating vector in this data set. The associated α matrix indicates that this cointegrating vector must enter the dynamic equation for productivity.

Table 3.5.7

Likelihood ratio tests

r	$-T\Sigma\ln(1-\lambda)$ Max r	$-T\ln(1-\lambda_r)$ r vs (r+1)
0	70.6	33.9
1	41.6	21.0
2	20.6	15.2
3	5.4	5.2
4	0.2	0.2

Table 3.5.8

Johansen's maximum likelihood estimates (1967Q1-1987Q4)

Eigenvalue	y-n-h	$w-p_f$	t_1	p_m-p_f	dc
0.30	-1	1.10	0.77	0.10	0.13

Table 3.5.9

<u>The adjustment coefficients from the α matrix</u>

y-n-h	$w-p_f$	t_1	p_m-p_f	dc
-0.37	0.01	-0.04	-0.01	-0.00

The α matrix, as well as the sign and the magnitude of the estimates, make the vector of Table 3.5.2 a good candidate for a long-run cointegrating vector in productivity. This vector is also theoretically preferable to the one given in Table 3.5.2. Interestingly, if the demand variable, dc, is dropped from the equation then the vector no longer cointegrates: the log likelihood values in the first row of Table 3.5.7 fall to 45.4 (from 70.6) and 25.7 (from 33.9). All the variables in Tables 3.5.8, including dc, are integrated of order 1, I(1), hence it is legitimate to include them together in the long-run vector.

The dynamic wage-productivity system based on the cointegrating vector of Table 3.5.9 for productivity and Table 2.5.4 for wages is presented in Table 3.5.10 below. This dynamic model was derived using the same procedure as that in Table 3.5.6. The associated VAR, which is very similar to the one for Table 3.5.6, was estimated and tested for constant parameters and normality, before testing the dynamic model presented in Table 3.5.10 for encompassing the associated VAR.

The wage equation in Table 3.5.10 has dynamic terms in productivity, wages and prices. The productivity term lengthens the average lag before productivity changes, implied by the error correction term rl, feed into wages. Dynamic price homogeneity holds since the dynamic terms in prices, $\Delta^2 p_{-1}$ and $\Delta^2 p_{-2}$, are second order differences.

The productivity equation has dynamic terms in wages, productivity and demand. The dynamic terms in wages shorten the the average lag before changes in wages, implied by the error correction term r2, feed into productivity. The lag dynamic term in productivity has the opposite effect, it lengthens the average lag before changes in any of the variables in the error correction term are fed into productivity. We shall return to the question of dynamics in the comparative framework below.

In the following section we provide wage-productivity systems for France and Germany before proceeding to discuss the cross-country comparisons.

Table 3.5.10

FIML estimation of the wage-productivity system in the UK

sample period: 1967Q2-1987Q1

$$\Delta(w-p_c(-1)) = \underset{(4.57)}{0.004} + \underset{(3.27)}{0.312}\Delta(w-p_c(-1))_{-1} + \underset{(4.51)}{0.417}\Delta(w-p_c(-1))_{-2}$$
$$- \underset{(3.22)}{0.443}\Delta(y-n-h)_{-1} - \underset{(4.73)}{0.821}\Delta^2 p_{-1} - \underset{(4.30)}{0.710}\Delta^2 p_{-2} - \underset{(5.55)}{0.453} r1_{-1}$$

where $r1 = (w-p_c) - 0.96(y-n-h) - 0.51t_2 + 0.64t_3 + 0.03us - 0.01mm$

SEE = 0.0117

$$\Delta(y-n-h) = \underset{(2.17)}{0.002} - \underset{(1.11)}{0.111}\Delta(y-n-h)_{-1} + \underset{(2.33)}{0.320}\Delta(w-p_f(-1))$$
$$+ \underset{(2.51)}{0.171}\Delta(w-p_f(-1))_{-1} - \underset{(1.90)}{0.019}\Delta dc_{-1} - \underset{(1.77)}{0.094} r2_{-1}$$

where $r2=(y-n-h) - 1.10(w-p_f) - 0.77t_1 - 0.10(p_m-p_f) - 0.13dc$

SEE = 0.009

Encompassing the VAR $\chi^2(13)=12.4$

3.6 The UK in a European perspective

In this section we try to shed some light on the reasons behind the differences in the performance of the UK labour market in comparison with France and Germany.

Tables 3.6.1 and 3.6.2 provide our estimates of the wage-productivity system for France and Germany respectively. The long-run vectors have been estimated using the Johansen technique. The dynamic models have again been estimated in the same manner as those in Tables 3.5.10 and 3.5.6. Details of the associated VARs, tests for normality and parameter constancy are provided in Appendix A3.2.

Table 3.6.1

FIML estimation of the wage-productivity system in France

sample period: 1967Q2-1987Q1

$$\Delta(w-p_c(-1)) = \underset{(1.11)}{0.002} + \underset{(1.71)}{0.221}\Delta(w-p_c(-1))_{-1} + \underset{(1.92)}{0.203}\Delta(w-p_c(-1))_{-2}$$

$$+ \underset{(1.94)}{0.157}\Delta(y-n-h) + \underset{(1.77)}{0.146}\Delta(y-n-h)_{-1} - \underset{(1.44)}{0.256}\Delta^2 p_{-1} - \underset{(2.10)}{0.145}rl_{-2}$$

where $rl = (w-p_c) - 1.04(y-n-h) - 0.99t_2 + 0.51t_3 + 2.27U$

SEE = 0.0073

$$\Delta(y-n-h) = \underset{(3.82)}{0.005} + \underset{(0.68)}{0.716}\Delta(y-n-h)_{-2} + \underset{(3.81)}{0.373}\Delta(w-p_f(-1)) + \underset{(3.19)}{0.017}\Delta dc_{-2}$$

$$- \underset{(2.01)}{0.089}r2_{-1}$$

where $r2 = (y-n-h) - 0.87(w+t_1-p_f) - 0.07(p_m-p_f) - 0.11dc$

SEE = 0.0063

Encompassing the VAR $\chi^2(7) = 12.08$

Table 3.6.2

FIML estimation of the wage-productivity system in Germany

sample period: 1967Q2-1987Q1

$$\Delta(w-p_c(-1)) = \underset{(1.48)}{0.004} - \underset{(0.85)}{0.086}\Delta(w-p_c(-1))_{-1} - \underset{(1.56)}{0.147}\Delta(w-p_c(-1))_{-2}$$

$$+ \underset{(4.23)}{0.388}\Delta(w-p_c(-1))_{-3} + \underset{(1.97)}{0.316}\Delta(y-n-h) - \underset{(2.63)}{0.059}\Delta ut_{-1}$$

$$- \underset{(4.06)}{1.033}\Delta^2 p + \underset{(3.95)}{0.650}\Delta(t_1)_{-1} - \underset{(2.27)}{0.194}rl_{-1}$$

where $rl = (w-p) - 0.96(y-n-h) -0.97t_1 - 0.92t_2 + 0.92t_3 + 0.09ut$

SEE = 0.017

$$\Delta(y-n-h) = \underset{(3.77)}{0.008} - \underset{(2.22)}{0.222}\Delta(y-n-h)_{-1} - \underset{(2.26)}{0.215}\Delta(y-n-h)_{-2}$$

$$+ \underset{(4.87)}{0.434}\Delta(w-p_f(-1)) + \underset{(5.37)}{0.798}\Delta t_1 + \underset{(1.81)}{0.016}\Delta dc_{-2} - \underset{(2.81)}{0.185}r2_{-1}$$

where $r2 = (y-n-h) - 0.95(w+t_1-p_f) - 0.08(p_m-p_f) - 0.05dc$

SEE = 0.012

Encompassing the VAR $\chi^2(10) = 14.3$

In Table 3.6.1, U is the unemployment rate and in Table 3.6.2, ut is the log of total unemployment. The exact definitions of the data are given in Appendix A3.1.

There are a number of preliminary remarks worth making before focussing our attention on wage determination in the three countries:

- In both France and Germany the restriction of equal coefficients on y-n and h is easily accepted.
- The demand constraint variable, dc, is necessary for the cointegration of the productivity equation in both France and

Germany.

- System estimation is essential since current change in wages appears in the productivity equation and current change in productivity appears in the dynamic wage equation.

The long-run productivity equations in both France and Germany are very similar to the one given for the UK in Table 3.5.8. One notable difference is the long-run impact of the demand term. The coefficient of the demand term for France (0.11) has a similar magnitude to that of the UK (0.13), however, in Germany this coefficient is particularly small (0.05)in comparison with the other two countries. Productivity and hence its constituents, output and employment, are twice as sensitive to changes in demand in France and the UK than in Germany.

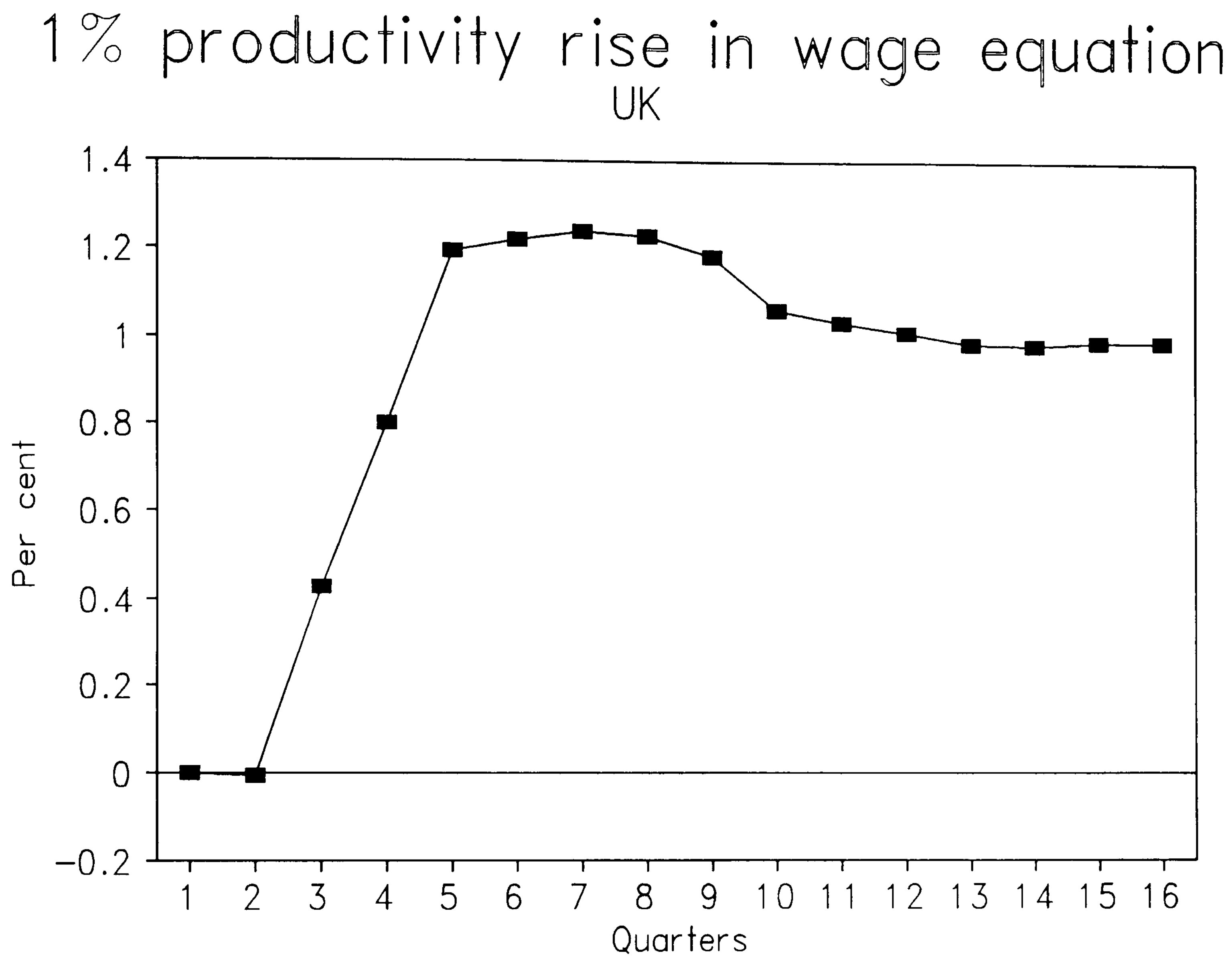
The German short-run productivity and in particular wage equation are richer in dynamics than those of the UK or France. One notable feature of the German equations is the slow adjustment path following a change in any of the determinants of wages or productivity. This is a consequence of the negative lagged dependent variables in the wage-productivity system.

Figures 3.6.1 to 3.6.12 illustrate some of the differences and similarities in the wage-productivity dynamics of the three countries. These step response figures roughly depict the adjustment path in wages or productivity following a one per cent rise in an explanatory variable. Consider the dynamic wage equations first, the consequence of a one per cent productivity rise in the three countries is depicted in Figures 3.6.1 to 3.6.3. In both France and Germany there is an instantaneous impact on wages. The adjustment to the long-run elasticity, implied by the error correction term, rl, is more rapid in France than in Germany. In the UK, there is no increase in wages in the first two periods, this is followed by a very sharp rise in wages in the following three periods to the extent that wage rises slightly over-shoot the long-run elasticity implied by the error correction term before converging to it.

Figures 3.6.4 to 3.6.6 provide the adjustment path for wages following a one per cent increase in the direct tax wedge. The adjustment is very rapid in the UK and again wages over-shoot the long-run elasticity on t_2 before converging on it. The adjustment in France and particularly in Germany takes place at a slower pace.

Figures 3.6.7 to 3.6.9 illustrate the adjustment path for productivity following a one per cent rise in wages. The most rapid convergence to the long-run elasticity takes place in France. The adjustment path in Germany is particularly slow and the speed of adjustment in the UK is between that of France and Germany. Figures 3.6.10 to 3.6.12 depict the adjustment path for productivity following a one per cent increase in the proportion of firms whose output is constrained by insufficient demand. Productivity in the UK and France is slow to adjust while in Germany there is an initial period of rapid adjustment followed by very slow convergence to the long-run elasticity.

Figure 3.6.1



1% productivity rise in wage equation
UK
Per cent
1.4
1.2
1
0.8
0.6
0.4
0.2
0
−0.2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Quarters

Figure 3.6.2

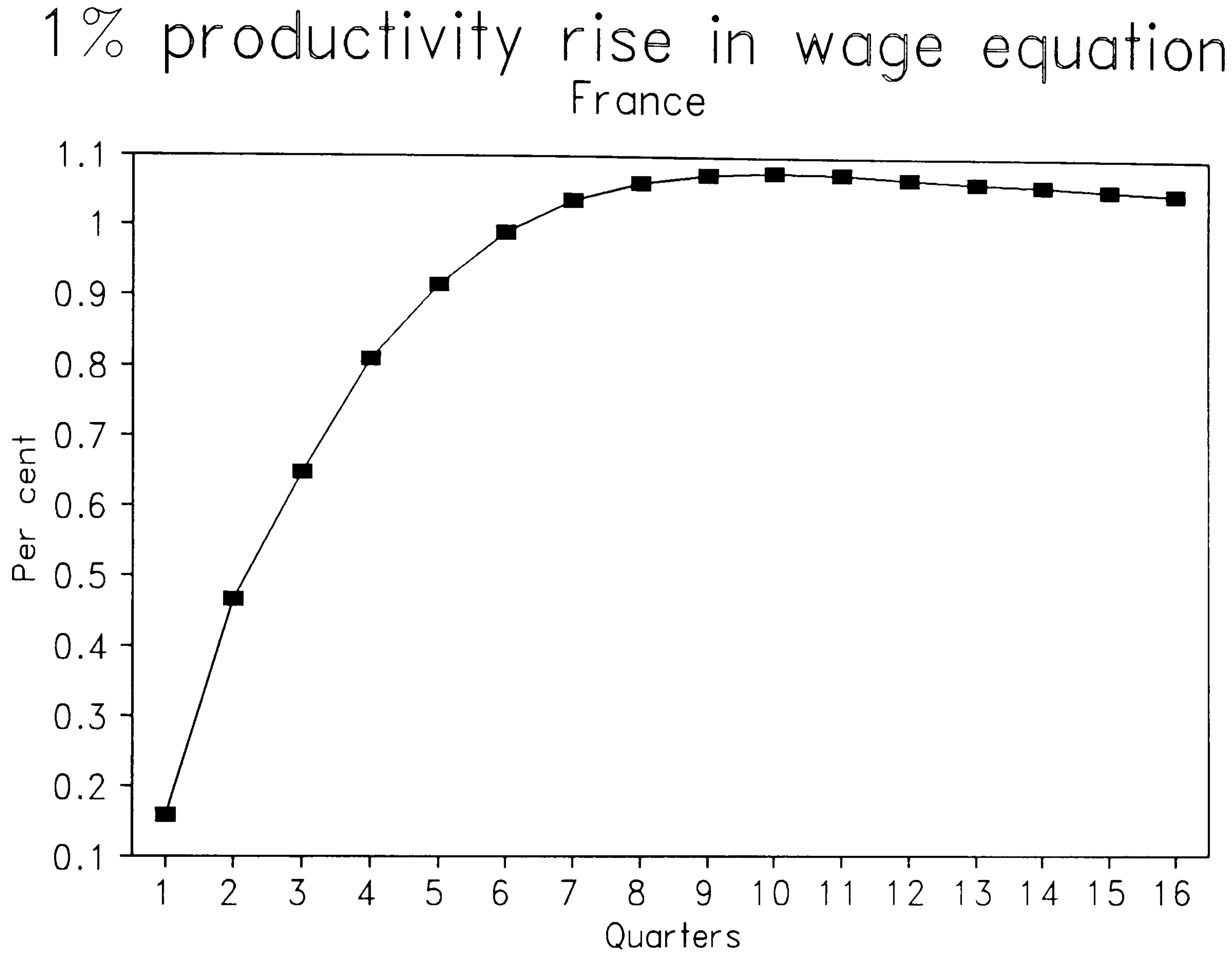
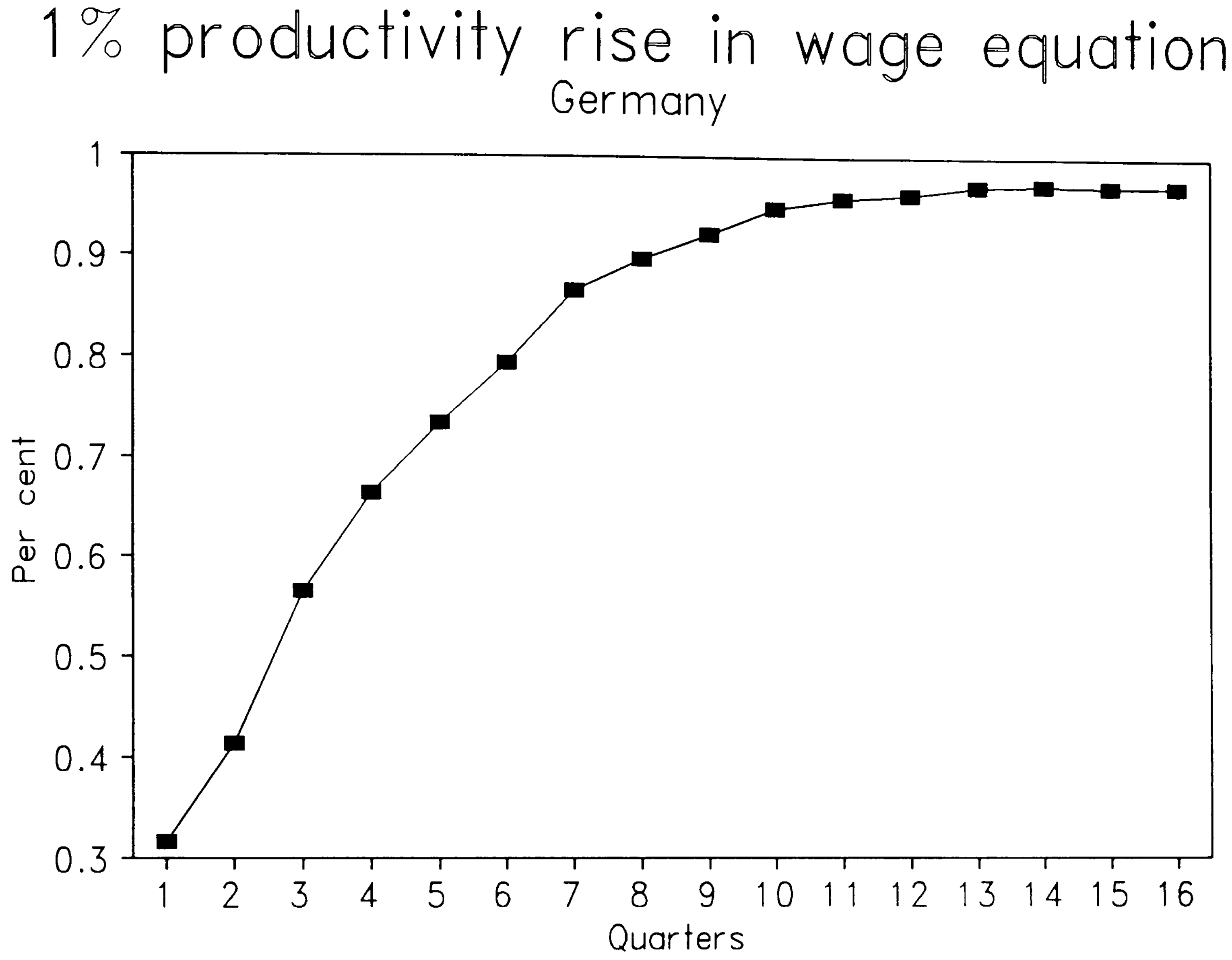

1% productivity rise in wage equation
France
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Per cent
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Quarters

Figure 3.6.3



1% productivity rise in wage equation
Germany
Per cent
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Quarters

Figure 3.6.4

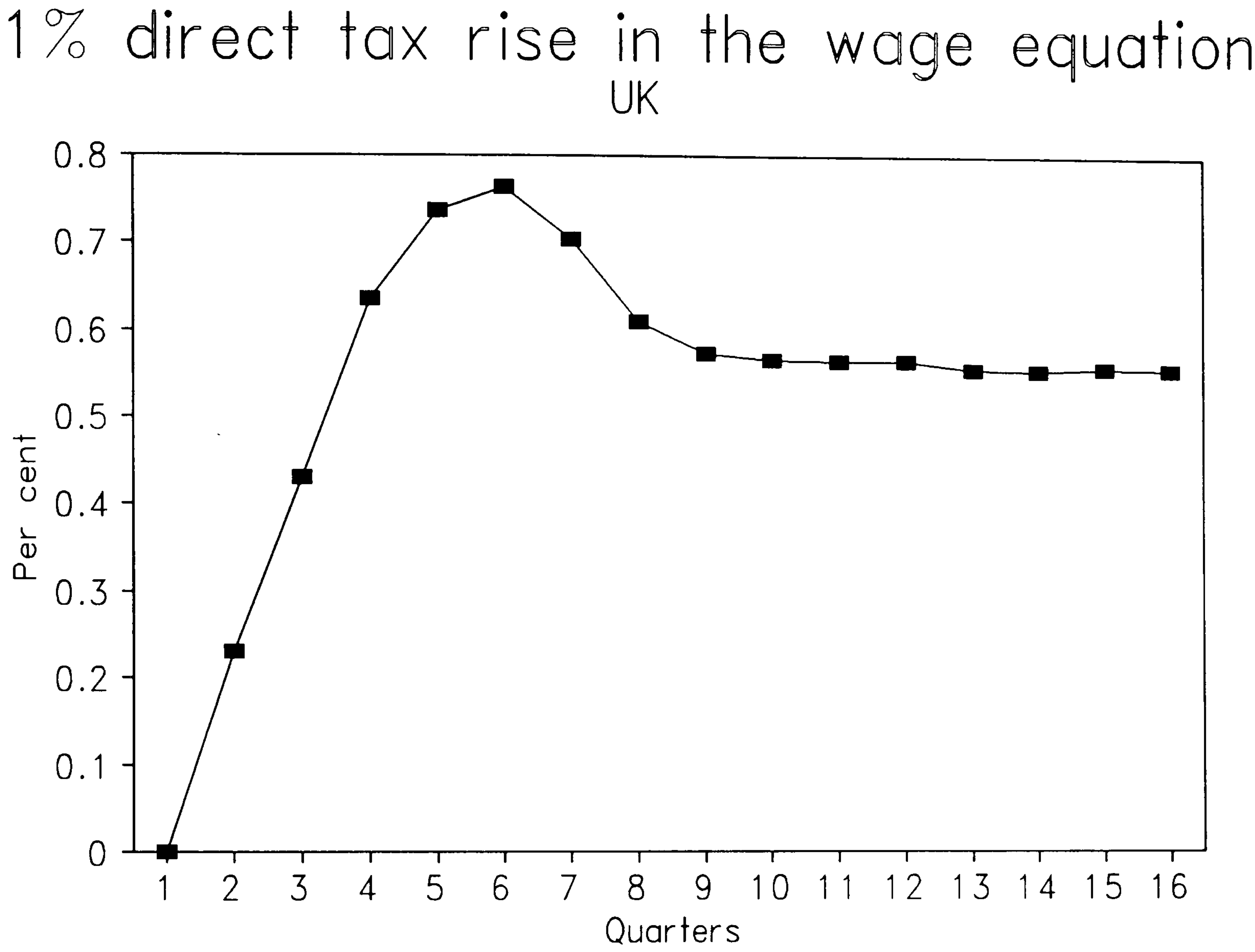

1% direct tax rise in the wage equation
UK
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Per cent
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Quarters

Figure 3.6.5

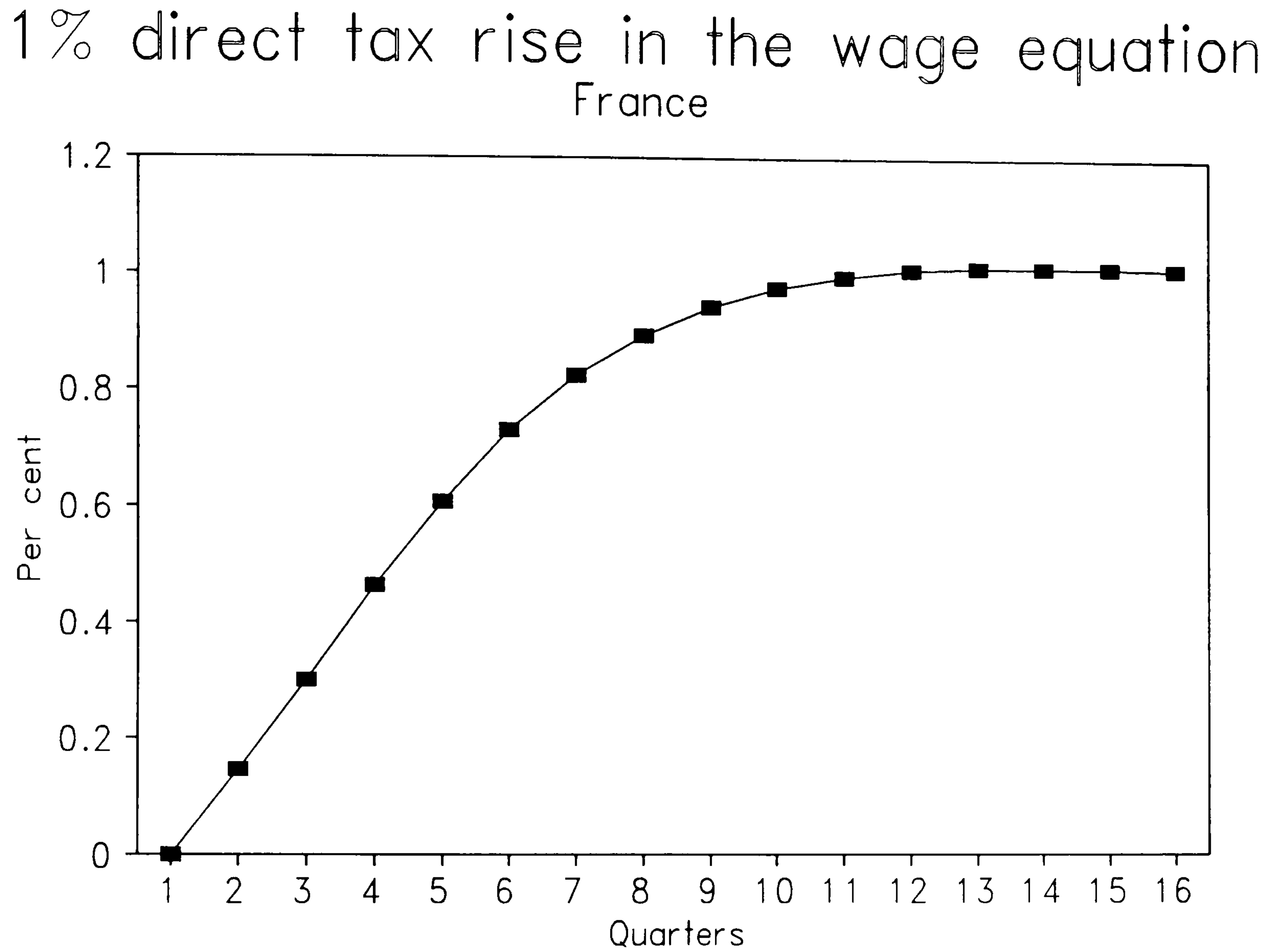

1% direct tax rise in the wage equation
France
1.2
1
0.8
0.6
0.4
0.2
0
Per cent
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Quarters

Figure 3.6.6

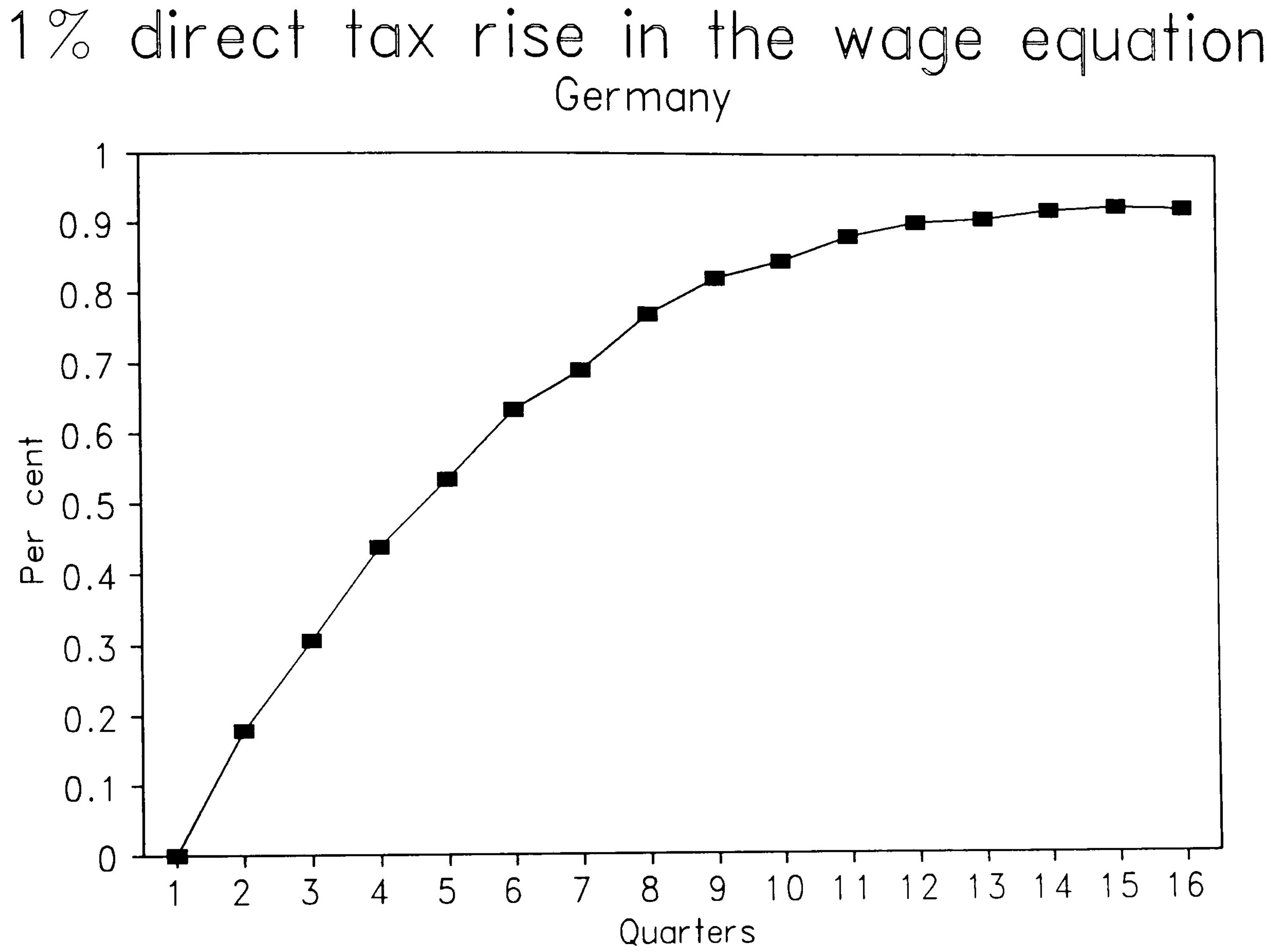

1% direct tax rise in the wage equation
Germany
Per cent
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Quarters

Figure 3.6.7

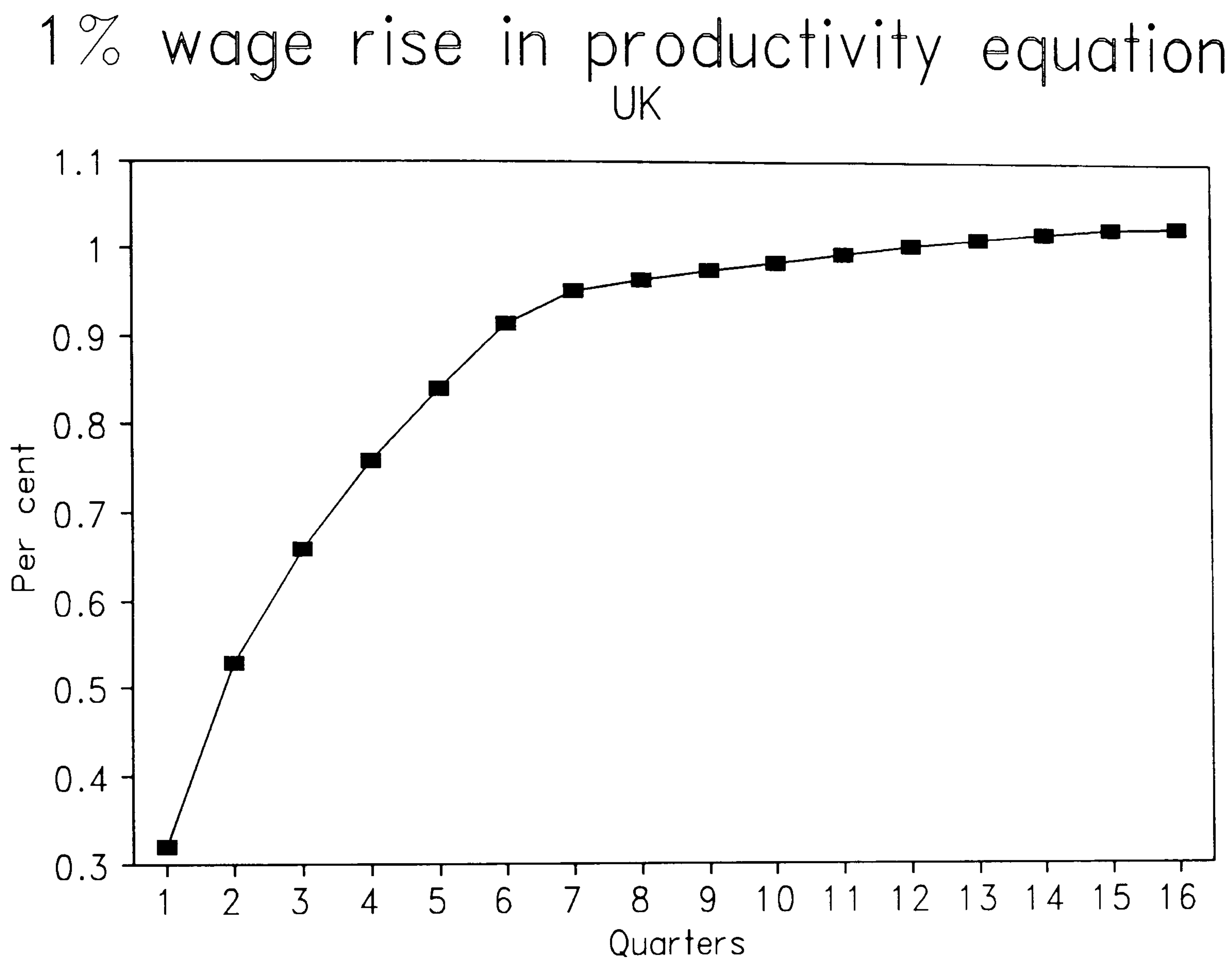

1% wage rise in productivity equation
UK
Per cent
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Quarters

Figure 3.6.8

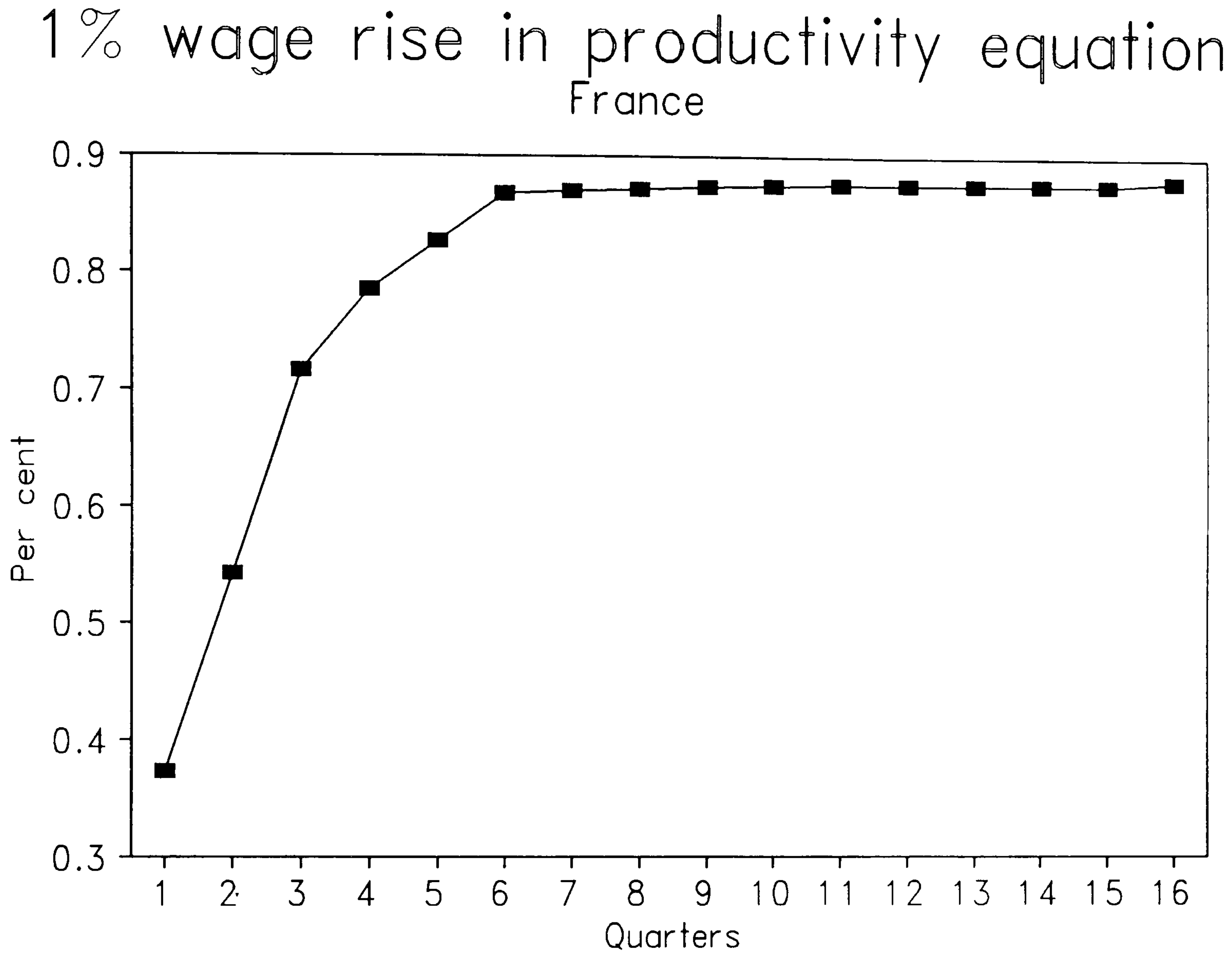

1% wage rise in productivity equation
France
Per cent
0.9
0.8
0.7
0.6
0.5
0.4
0.3
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Quarters

Figure 3.6.9

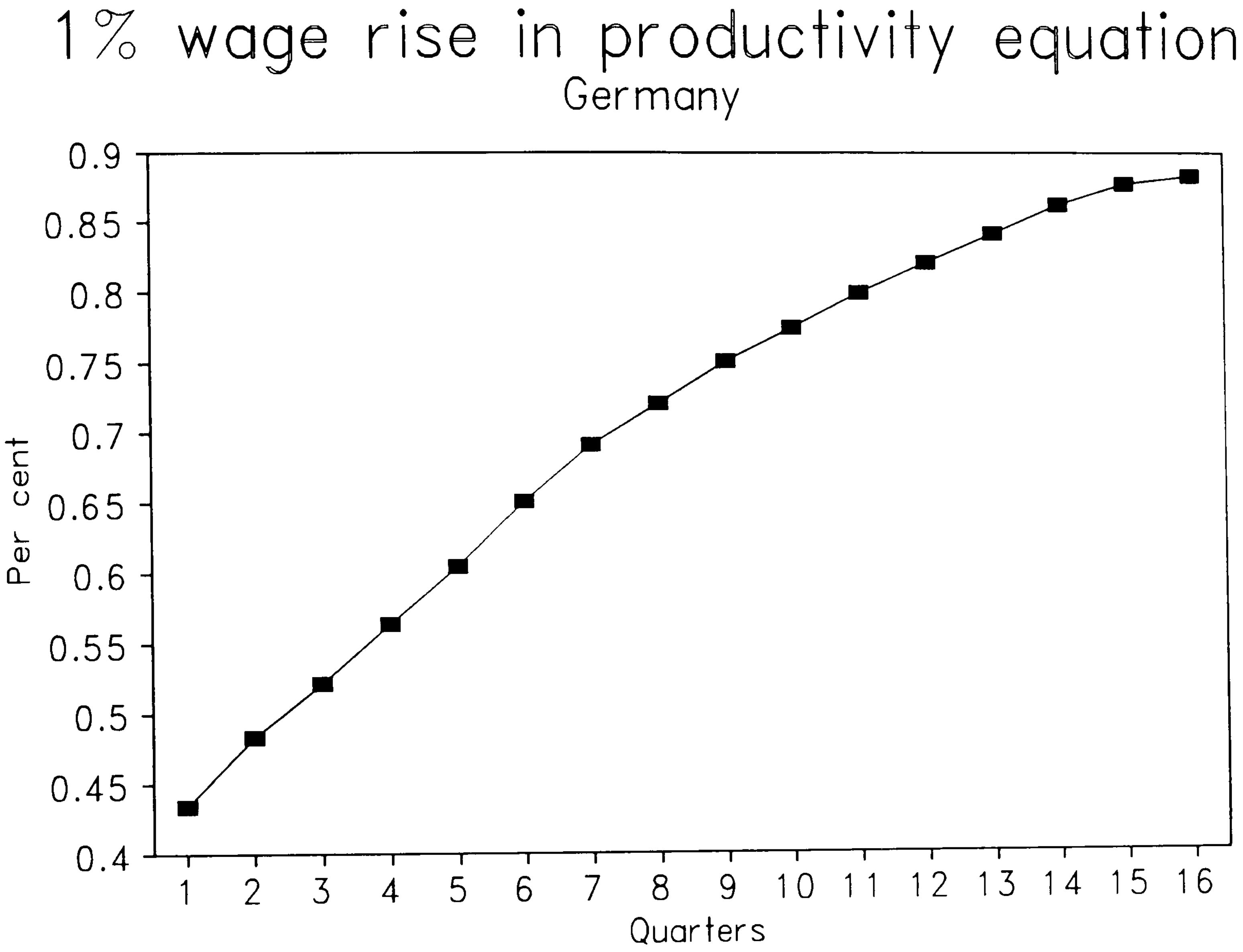

1% wage rise in productivity equation
Germany
Per cent
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Quarters

Figure 3.6.10

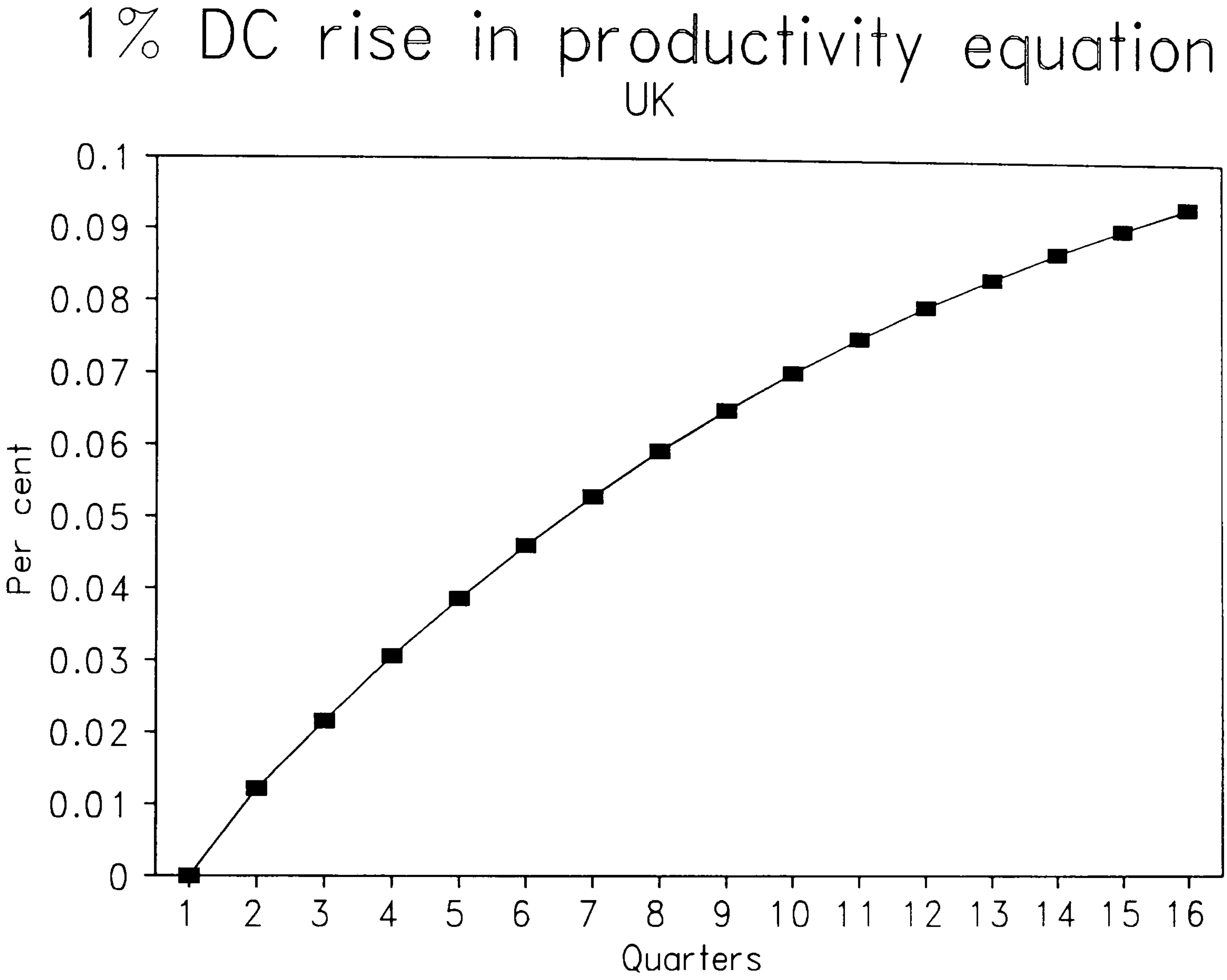
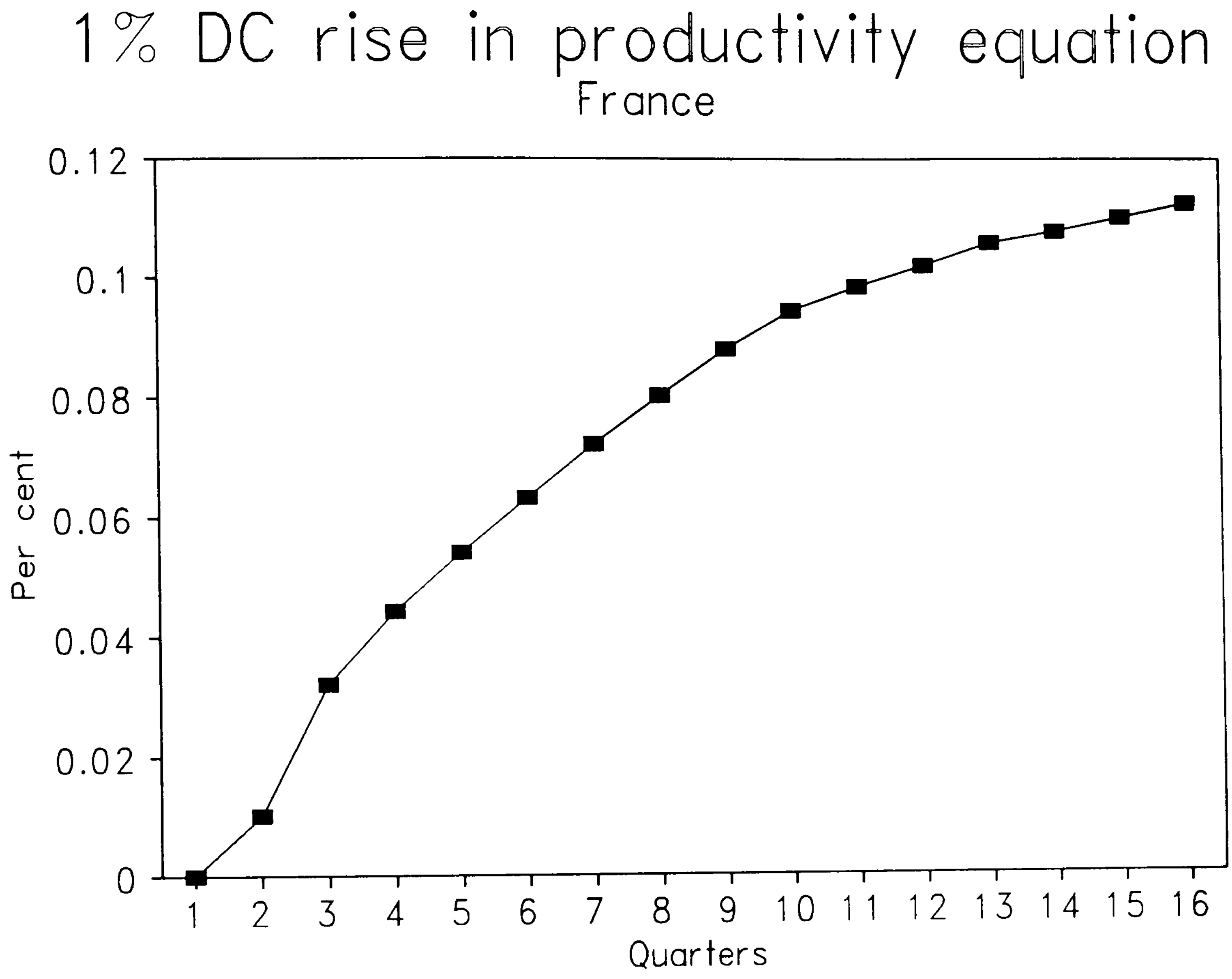
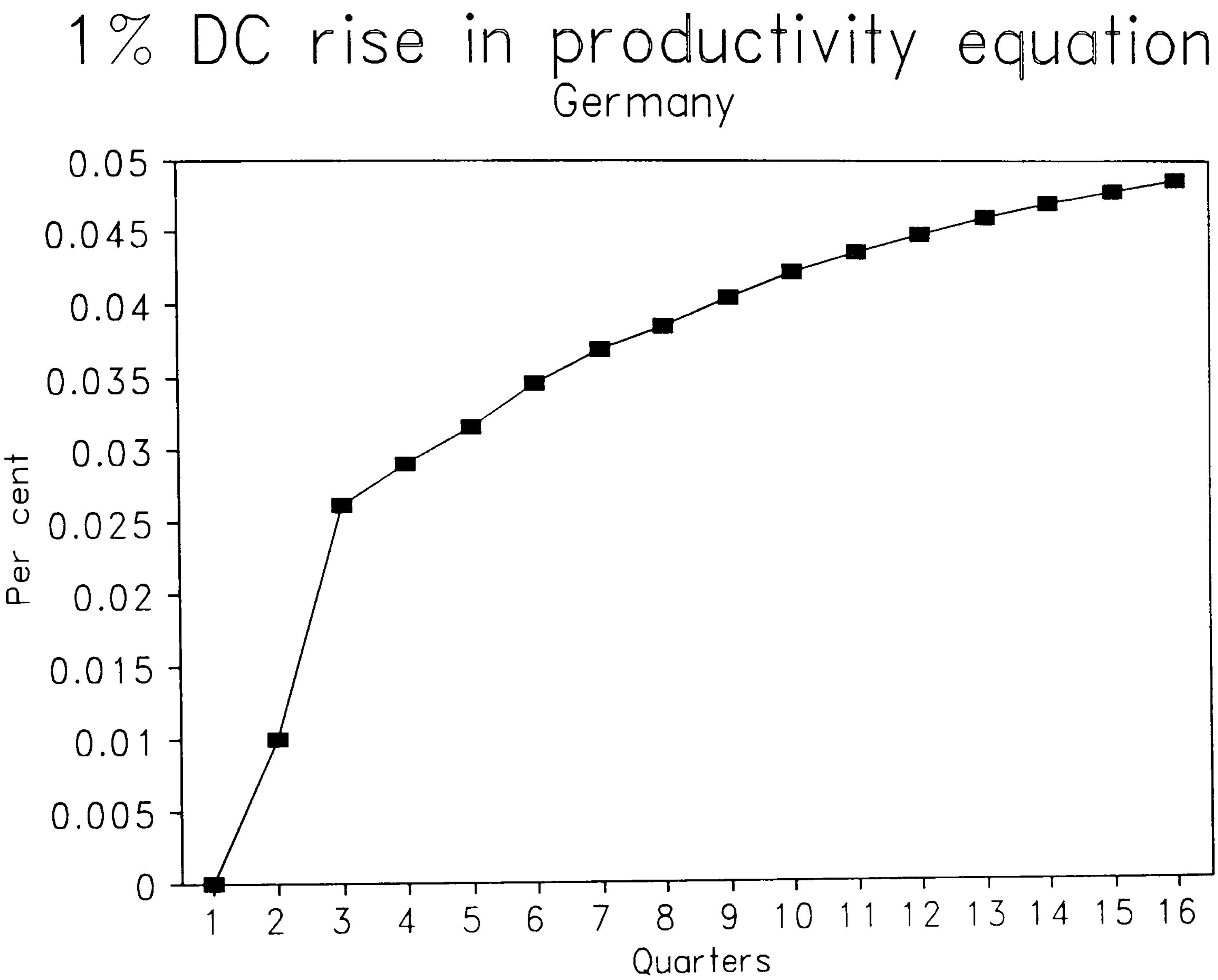

1% DC rise in productivity equation
UK
Per cent
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Quarters

Figure 3.6.11



1% DC rise in productivity equation
France
0.12
0.1
0.08
0.06
0.04
0.02
0
Per cent
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Quarters

Figure 3.6.12


1% DC rise in productivity equation
Germany
Per cent
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Quarters

We mentioned in our survey of the previous multi-country studies that many scholars have produced measures of nominal and real wage rigidities across countries. Grubb et al. (1983) and Nickell (1990) define nominal wage rigidity as the long-run unemployment cost of reducing inflation by one point and real wage rigidity as the extent to which wage pressure is converted into unemployment at constant inflation. In our wage-productivity system nominal wage rigidity would be the coefficient on inflation, $\Delta^2 p$, if we solve the system for unemployment. Real wage rigidity would be the long-run coefficient on unemployment in a wage equation. However, our three unemployment variables are not directly comparable. In France the unemployment variable is simply the unemployment rate, in Germany it is the log of the unemployment rate and in the UK it is the log of the short-term unemployment rate. To make comparison possible we have divided the coefficient of the unemployment variables in the UK and Germany, which are in logs, by the average value of these variables during the sample period and then calculated nominal and real wage rigidity according to the Grubb et al (1983) definition.

Table 3.6.3

Nominal and real wage rigidities

	Nominal	**Real**
UK	1	1
France	0.2	0.40
Germany	0.7	0.45

Table 3.6.3 gives nominal and real rigidities in France and Germany

relative to the UK. Both nominal and real wage rigidities are highest in the UK and lowest in France.

Turning to the main purpose of our study, wage determination, we note that in France and Germany, as in the UK, the long-run coefficient on productivity is not very different from one. The tax wedges exhibit different properties in each country, although they are all correctly signed. In Germany, a one per cent cut in direct taxes has nearly the same effect on real earnings as a one per cent cut in direct taxes or a one per cent reduction in the employers' taxes. A one per cent increase in indirect taxes in France adds less to wages than a similar increase in direct taxes. Employers' taxes are absent from the long-run wage equations for France and the UK, however, they appear in the German equation with a near unit coefficient.

The most significant difference in the wage-productivity system of the three countries lies in the impact of unemployment. In both France and Germany we were unable to obtain cointegrating equations for wages with short-term unemployment. The most satisfactory unemployment variable for Germany was found to be the log of total unemployment. For France, cointegration could only be obtained by entering the total unemployment rate itself (unlogged). In our analysis of Chapter One we found that the long-term unemployed exert no presure on wage inflation in the UK. Table 3.6.4 gives simple OLS estimates of the long-run wage equations for France and Germany with the addition of the proportion of long-term unemployed. We found this variable to be significant and positive in our long-run analysis of the UK wage equation in Chapter One.

Table 3.6.4

The impact of the proportion of long-term unemployed on wages

	Germany	France
OLS - Sample 1967q1-87q4		
$w-p_c$	-1	-1
c	2.04	-0.05
	(1.83)	(3.64)
t1	-1.16	---
	(6.11)	---
t2	0.56	1.03
	(1.93)	(6.40)
t3	-0.53	-0.22
	(4.74)	(1.37)
ut	-0.07	---
	(8.76)	---
U	---	-1.93
	---	(5.56)
PLU	-0.47	-0.18
	(10.56)	(2.67)
SEE	0.022	0.014
DW	1.17	1.09

The proportion of long-term unemployed, PLU, in both France and Germany is significant but negative. In France and Germany, unlike the UK, those who have been unemployed for more than a year still exert pressure on wages. Nickell (1990) in his study of OECD unemployment, found that hysteresis is only a feature of wage determination in the UK. Jackman et al. (1990) argue that long-term unemployment and insider-outsider effects are synonymous with hysteresis. Our results here are consistent with both of these studies. The question arises as to why wage determination in the UK is different in this respect to France and Germany although the wage-productivity models in the three countries are fairly similar in other respects. Table 3.6.5 may help to shed some light on this matter.

Table 3.6.5

Proportion of firms whose output is constrained by a shortage of skilled labour (%)

Year	UK	France	Germany
1975	17	5	5
1976	13	6	4
1977	19	5	4
1978	23	3	5
1979	22	4	10
1980	8	4	12
1981	3	3	5
1982	4	4	2
1983	6	4	1
1984	10	3	2
1985	14	3	3
1986	15	3	4
1987	19	4	3
1988	26	5	4
1989	27	3	4

The European Community Business Survey also asks firms in France, Germany and the UK whether their output is constrained by shortages of skilled labour. The above table provides annual averages of the percentage of firms whose output has been constrained by the lack of skilled labour. UK firms have been more often constrained by skilled labour shortages than their European counterparts especially during periods of economic expansion. The question is, does this matter for wage determination? To answer this we included a time series of this variable in our long-run vector of wages. Neither in France nor in Germany could we obtain a meaningful long-run vector of wage determinants which included this variable in spite of trying both the Johansen technique and OLS. However, when this measure of skill shortages is included in the long-run vector for the UK it makes the short-term unemployment variable insignificant; when we drop the short-term unemployment rate, the skill shortage variable is highly significant. The results are provided in Table 3.6.6.

Table 3.6.6

The impact of the skill shortages on wages in the UK
OLS estimates, sample 1967q1-87q4

	I	II	III
$w-p_c$	-1	-1	
c	-0.0449 (0.73)	0.0565 (0.61)	0.1005 (1.61)
y-n-h	0.9639 (29.0)	0.8973 (13.43)	0.8727 (15.85)
t2	0.5142 (4.33)	0.4221 (3.08)	0.3762 (3.20)
t3	-0.6440 (7.38)	-0.6258 (3.40)	-0.6295 (3.44)
us	-0.0303 (2.99)	-0.0113 (0.66)	——
mm	0.0101 (4.51)	0.0179 (5.02)	0.0182 (5.20)
sk	——	0.0082 (1.35)	0.0113 (2.92)
SEE	0.0182	0.0177	0.0177
DW	1.04	1.22	1.20

Table 3.6.6 provides three cointegrating vectors, the first is the long-run vector estimated in the last chapter which forms the long-run solution of our dynamic wage model for the UK. The second vector also includes an index of skill shortages. When this variable is added to the equation, the short term unemploymnent rate becomes insignificant. In the third model we drop the short-term unemployment variable while retaining the skill shortage measure. The index of skill shortages is highly significant and the standard error of the last equation is smaller than the first cointegrating vector. When it comes to exerting pressure on wages, short-term unemployment and skill shortages seem to be synonymous in the UK. This impression is confirmed when we look at Figure 3.6.13 which depicts the short-term unemployment rate and the proportion of firms reporting skill shortages. To make the two variables comparable on the same scale, we have divided the proportion of firms reporting that their production is constrained by shortages of skilled labour by 10. The two variables are almost a mirror image of each other: a fall in skill shortages often coincides with a rise in short-term unemployment. However, skill shortages start to rise before any economic recovery begins to reduce short-term unemployment.

The period between 1983 and 1986 is a particularly interesting one. Figure 3.6.13 shows that between 1983 and 1986 short-term unemployment remained steady. This is also true of total unemployment. However, the percentage of firms reporting that their output was constrained by skill shortages started to rise in 1983. Table 3.6.7 gives the total change in the value of the variables in our long-run model of UK wages between 1983 and 1986.

Figure 3.6.13

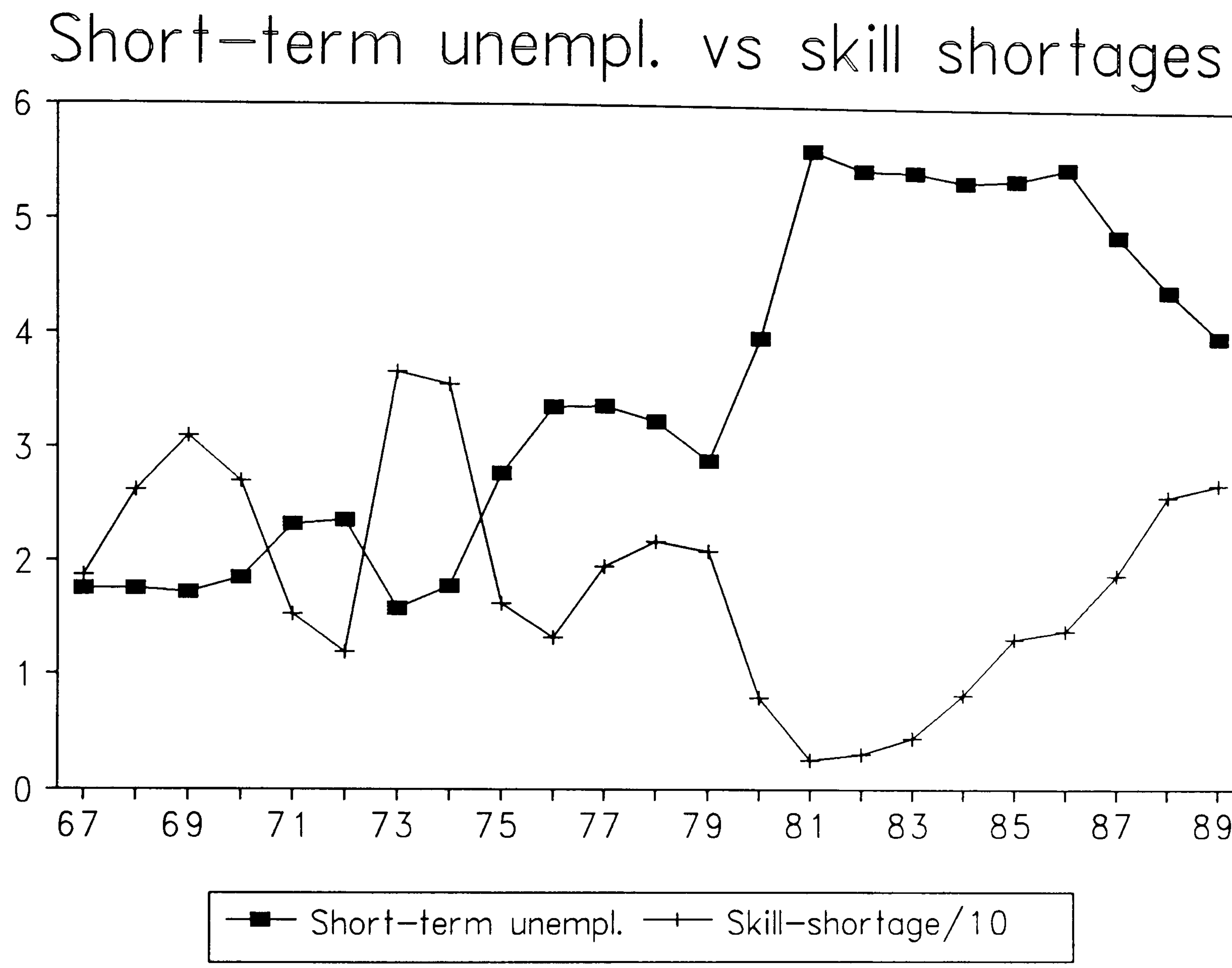

Short-term unempl. vs skill shortages
6
5
4
3
2
1
0
67
69
71
73
75
77
79
81
83
85
87
89
Short-term unempl.
Skill-shortage/10

Table 3.6.7

<u>Change in model variables 1983-1986</u>

Real wages	8%
Direct tax wedge	0.01
Indirect tax wedge	0.02
Productivity	6%
Mis-match	0
Short-term unemployment	0
Skill shortages	230%

We must note that the direct and indirect tax wedges in our model are not in log form and that the changes in these variables, given in the table above, are actual, not percentage changes.

How well do our models of long-run wages explain the rise in the real wages between 1983 and 1986, a period of steady unemployment? Table 3.6.8 compares the performance of the two long-run models presented in Table 3.6.6. Model I, with short-term unemployment, is compared with model III, with skill shortages.

Table 3.6.8

Breakdown of the rise in the real wage

	model I with short-term unemployment	model III with skill shortages
Direct tax wedge	0.003	0.004
Indirect tax wedge	-0.013	-0.013
Productivity	5.76%	5.22%
Mis-match	0	0
Short-term unemployment	0	0
Skill shortages	_	2.50%
Total explained	5.7%(approx)	7.7%(approx)
Actual	8%	8%

Model III, with skill shortages, explains about 7.7 per cent of the 8 per cent rise in real wages between 1983 and 1986 whereas model I, with short-term unemployment, explains only about 5.7 per cent of the rise in real wages.

This simple analysis indicates that during the period of economic expansion between 1983 and 1986, skill shortages can be regarded as a better indicator of the pressure on wages than short-term unemployment. However, the explanatory power of the model with skill shortages is no worse than the model with short-term unemployment during other periods. For instance, between 1979 and 1982 when the British economy experienced a severe recession, real wages increased by approximately 7.5 per cent. For this period both long-run models over-estimate the rise in real wages. Model I, with short-term unemployment, gives a rise of about 8.2 per cent, whereas the model with skill shortages indicates an increase of 7.8 per cent in real wages. The model with skill shortages performs marginally better than the one with short-term unemployment.

3.7 Conclusion

In this chapter we extended our analysis of wage determination in the UK by assessing this aspect of the UK labour market in a European context. To start with, we developed our theoretical model of wages into a broader wage-productivity framework, allowing for the joint determination of wages and employment, and hence, wages and productivity. Special emphasis was also put on utilising an appropriate econometric methodology.

In the empirical section of the chapter we provided estimates of the wages-productivity system for the UK, France and Germany. The comparative framework yielded a number of interesting findings. For instance, we discovered that a measure of demand is necessary in the long-run productivity equation if it is to form a cointegrating vector. The most significant results of the chapter were uncovered when comparing wage determination in the UK with that of the other two countries. In particular, we learned that long-term unemployment does exert downward pressure on wages in both France and Germany, but not in the UK. To shed some light on this finding we investigated the role of skill shortages in the three countries. We were unable to detect any pressure on wages caused by skill shortages in either France or Germany. However, in the UK, skill shortages provided a good alternative to short-term unemployment in determining wages. In fact, the long-run vector with skill shortages was found to be better at explaining the rise in real wages.

The results of this chapter, especially those regarding skill shortages, must be considered illustrative rather than conclusive. We do not claim that it is skill shortages rather than any other variable which must appear in the wage equation, however, this is a source of pressure on wages which has not been fully investigated before. If the problem with wage inflation stems from skill shortages, the solution is simple: training.

The results of this chapter regarding wage determination, as well as those presented in the previous chapter, merit further investigation, especially at a more disaggregate level. We shall turn to a study of wages at industry level in the next chapter before turning to the determinants of wages at the individual level in Chapter Five.

Appendix A3.1

Data definition and Sources

United Kingdom

All the data are exactly as describes in Appendix 2A.1. In addition the following variables have also been used in this Chapter:

DC percentage of firms whose output is constrained by lack of demand or orders for the firm's product. CBI Industrial Trends Survey and European Community Business Survey.

P_f output price index, 1980=100. Economic Trends.

SK percentage of firms whose output is constrained by shortages of skilled labour. CBI Industrial Trends Survey and European Community Business Survey.

Germany and France

All of the following variables were retrieved from the National Institute's Global Economic Model (GEM) database. They are down loaded from OECD tapes and Datastream, unless stated otherwise.

DC percentage of firms whose output is constrained by lack of demand or orders for the firm's product. European Community Business Survey.

H average hours worked per operative in manufacturing (GB), index 1980=100. OECD Main Economic Indicators.

MM an index of mismatch, as in Layard and Nickell (1986). Calculated from OECD Main Economic Indicators.

N employment total, UK, thousands. OECD Main Economic Indicators.

P_c consumer price index, 1980=100. OECD main Economic Indicators.

P_f output price index, 1980=100. OECD Main Economic Indicators.

PLU proportion of the unemployed who have been out of work for more than a year. For Germany this was calculated from Amtliche Nachrichten der Bundesanstalt fur Arbeit. For France the figures are from Enquete sur l'emploi.

PM deflator, total imports, 1980=100. OECD Main Economic Indicators.

SK percentage of firms whose output is constrained by shortages of skilled labour. European Community Business Survey.

t_1 employment tax borne by the firm defined as (EC + CON)/(IE - EC) where EC is employers' contributions; CON is employers contributions and IE is income from employment. Transformed from OECD National Accounts.

t_2 income tax wedge, (TXPER + HC)/(IE -EC) where TXPER is tax of persons' income and HC is households' contribution to social security. EC and IE are as in t_1. Transformed from OECD National Accounts.

t_3 indirect tax wedge, indirect taxes net of subsidies as a proportion of consumers' expenditure. Transformed from OECD National Accounts.

U unemployment, thousands. OECD main Economic Indicators.

US short-term unemployment defined as U026/(N + U026) where U026 is the number of people, aged 18 or over, who have been unemployed for less than 26 weeks. For Germany this was calculated from Amtliche Nachrichten der Bundesanstalt fur Arbeit. For France the figures are from Enquete sur l'emploi.

UT total unemployment rate. OECD Main Economic Indicators.

W average weekly earnings, DM or Franks per week. OECD Main Economic Indicators.

Y gross domestic product, output measure, 1980=100. OECD Main Economic Indicators

Appendix A3.2

This Appendix presents the results of the normality and scaled 'Break Point' Chow tests for the German and French wage-productivity systems.

Table 3A.1

χ^2-test for normality for Germany

	$\Delta(w-p_c(-1))$	$\Delta(y-n-h)$
$\chi^2(2)$	1.50	4.13

Table 3A.2

χ^2-test for normality for France

	$\Delta(w-p_c(-1))$	$\Delta(y-n-h)$
$\chi^2(2)$	3.3	4.18

eak Point' Chow Tests for ($w-p_c(-1)$)
Germany

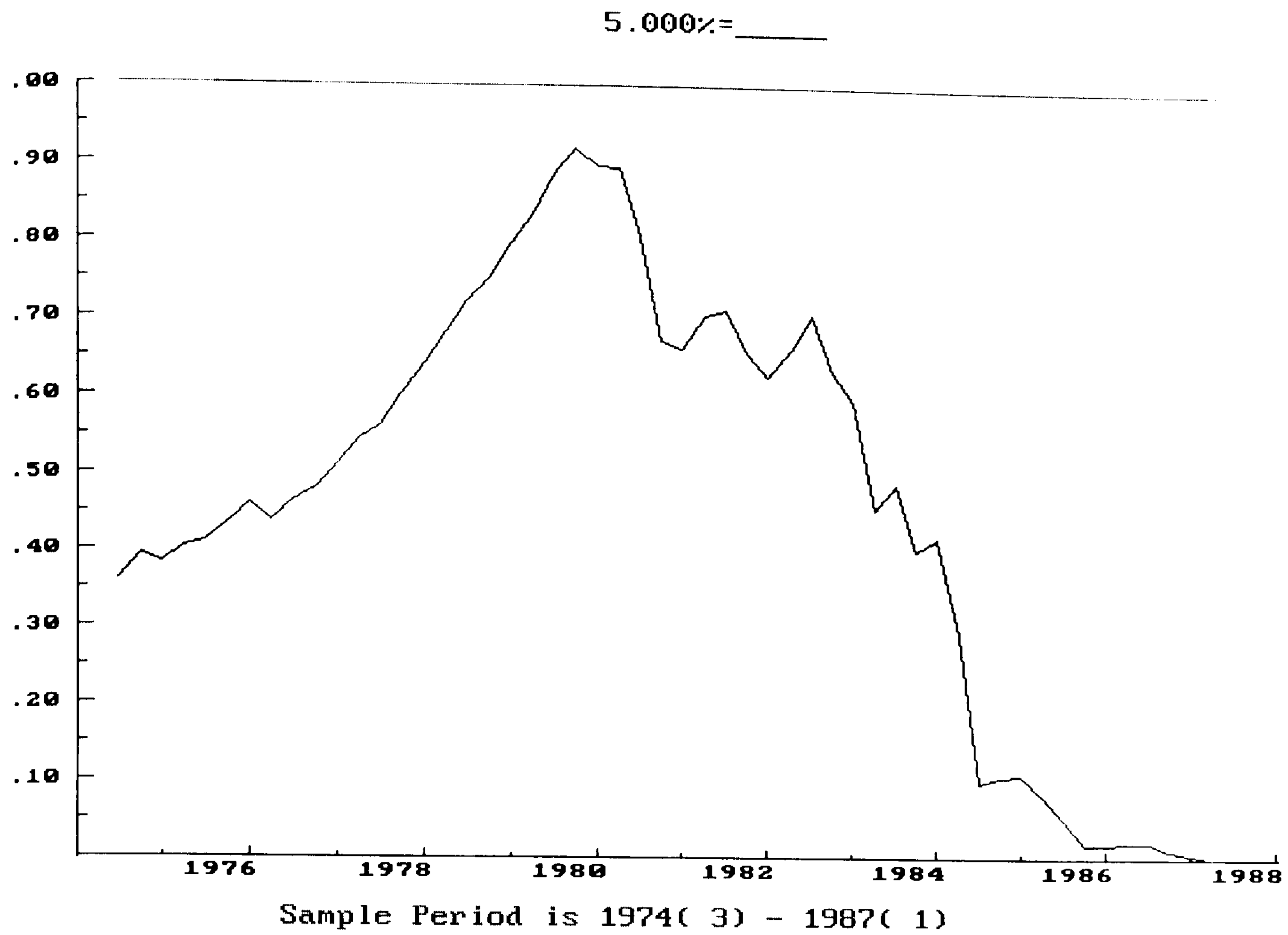
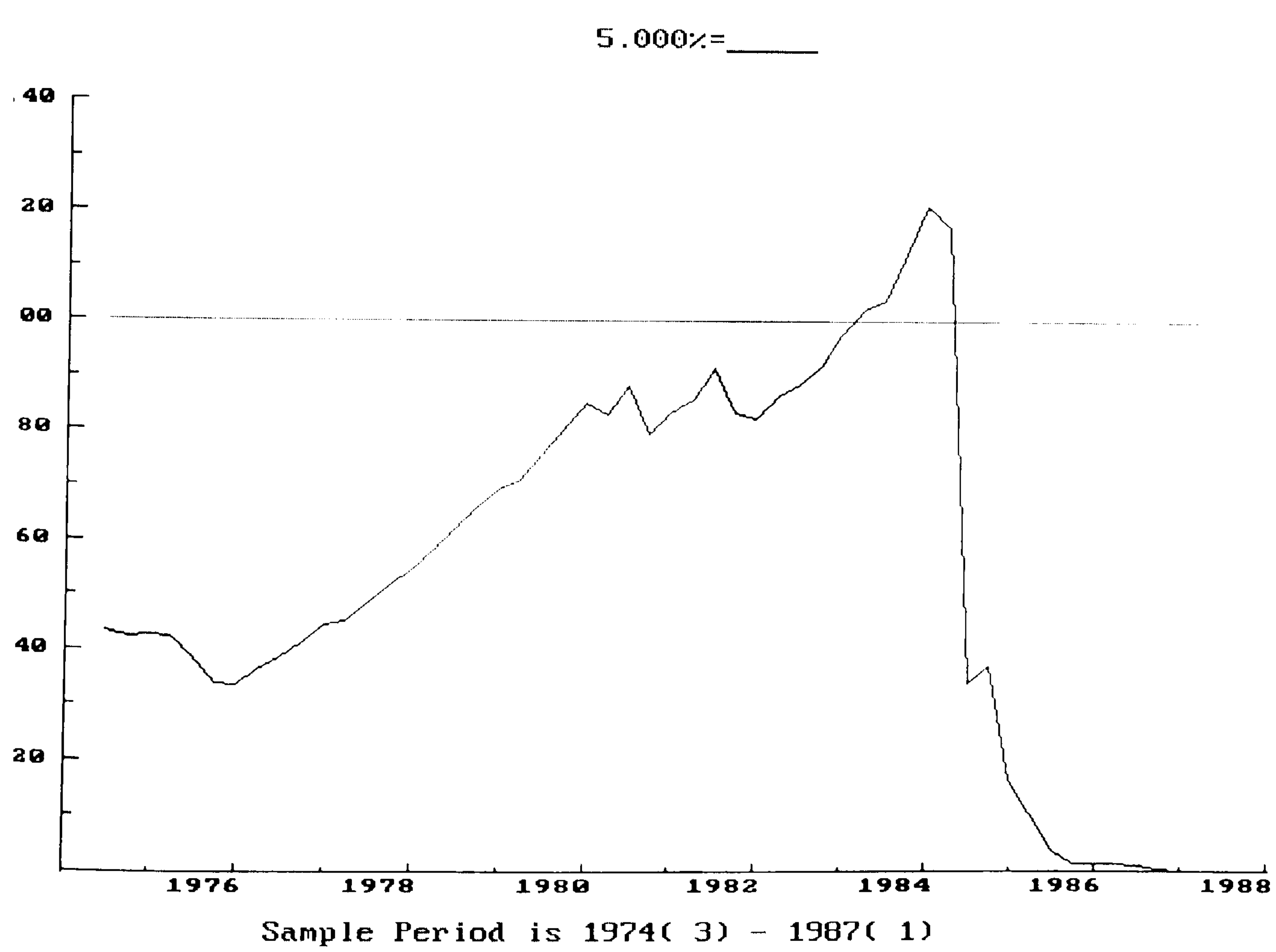


Figure A3.2 Scaled 'Break Point' Chow Tests for (y-n-h) - Germany



... Point' Chow Tests for $(w-p_c(-1))$

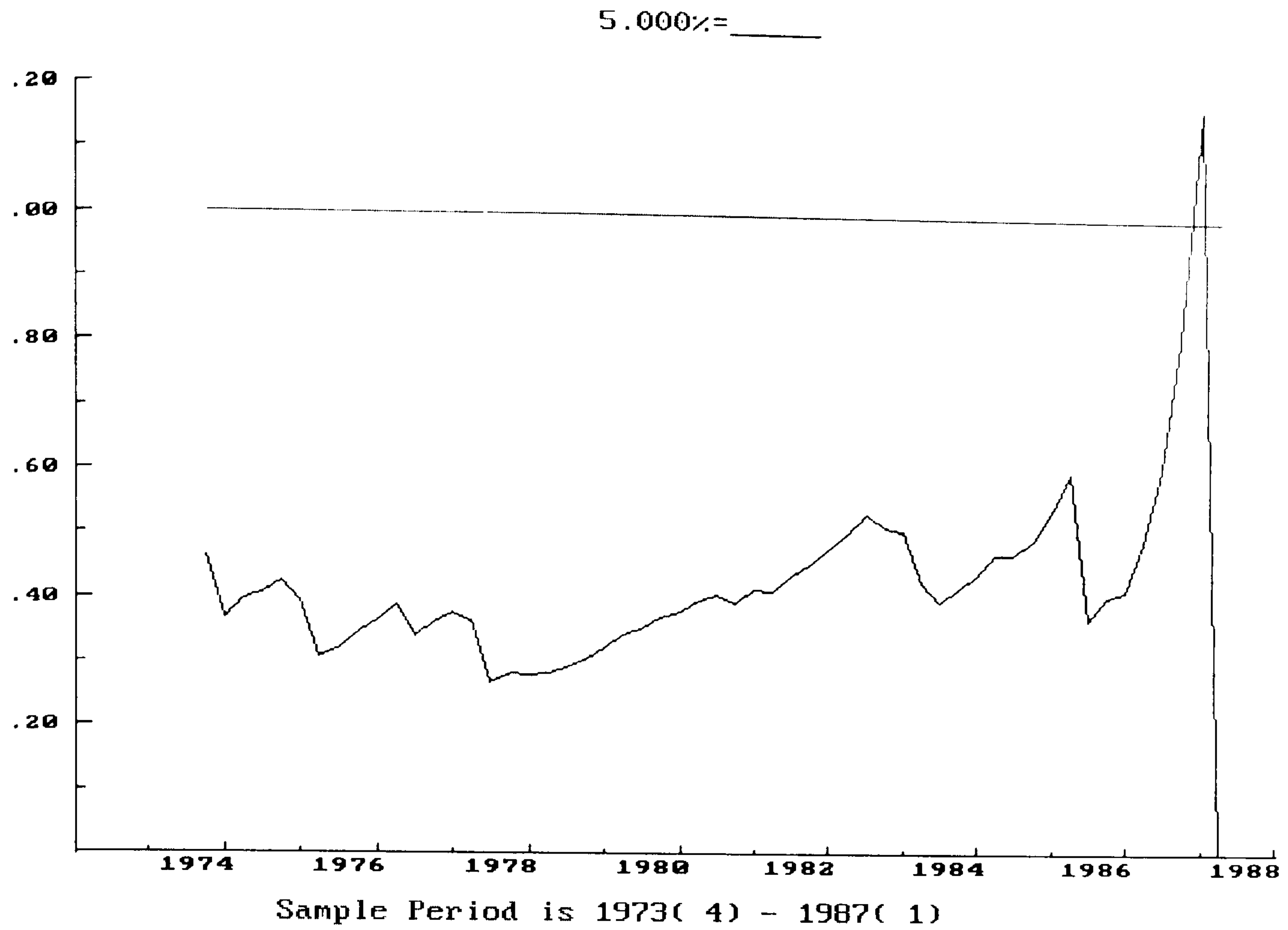
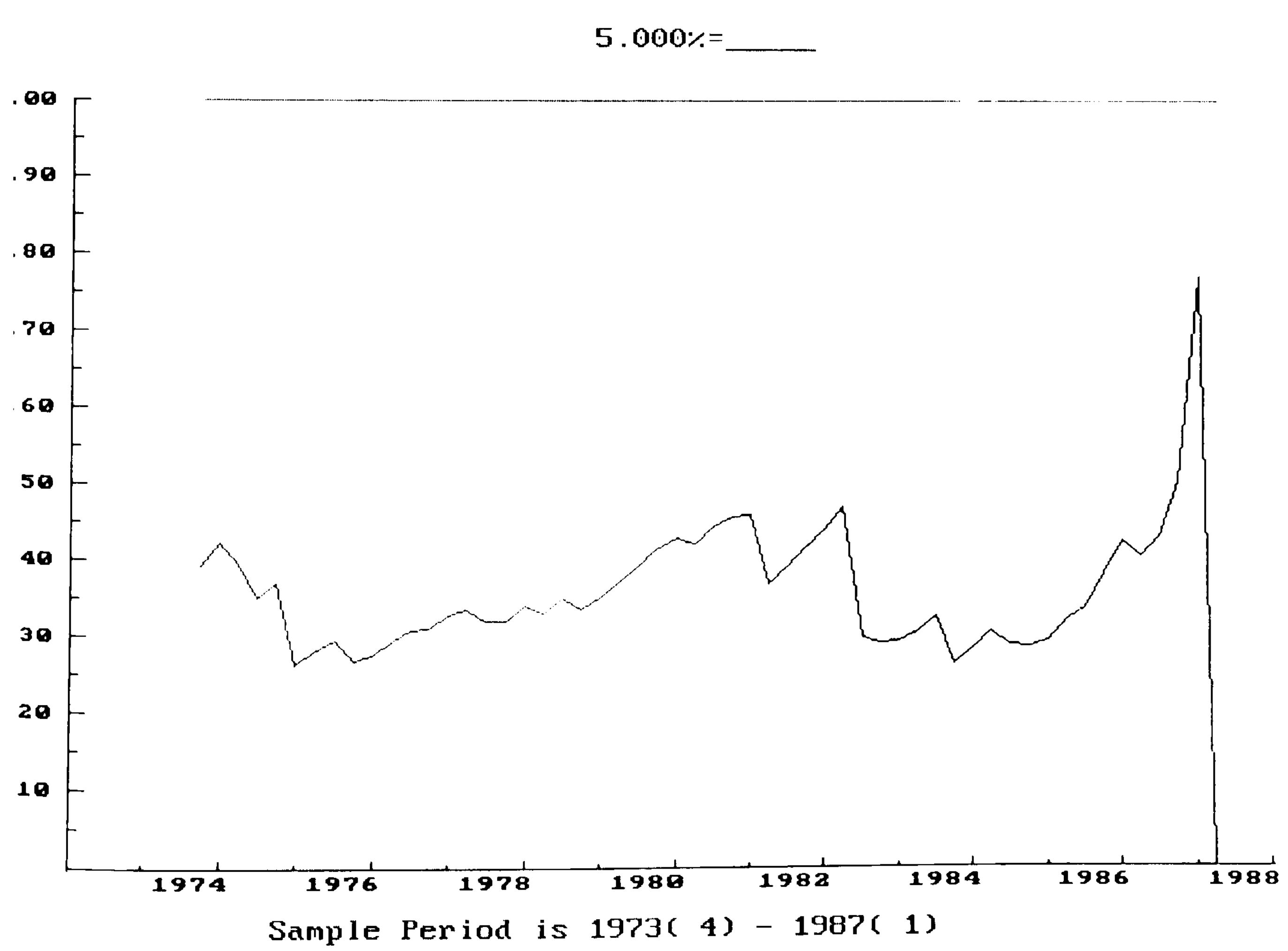


Figure A3.4 Scaled 'Break Point' Chow Tests for (y-n-h) - France



Chapter Four

Relative Wage Flexibility in the United Kingdom, the United States and Sweden

4.1 Introduction

In a modern economy there is a continuous need to reallocate labour between sectors as the labour requirements of different sectors of the economy change. Technological advances change labour requirements at given output and prices. Furthermore, the demand for final and intermediate goods shifts in response to changes in tastes and technology and foreign competition changes the pattern of demand from home and abroad. In the previous two chapters we concentrated on wages at the aggregate level. However, such aggregate studies do not reveal whether sectoral wages respond to labour requirements. This is the question which we address in this chapter.

The reallocation of labour can be brought about in two ways, via 'quantity signals' and via 'price signals'. The quantity signals consist of various measures taken by firms in the expanding sectors of the economy to recruit labour at given wages. New vacancies are created and intensive recruitment campaigns take place. New entrants to the labour market and unemployed workers are encouraged to look for jobs where they can be found, without much regard to expected earnings.

Price signals are transmitted through relative wages. Firms in the expanding sectors raise their relative wages to attract labour away from firms in the declining sectors. Job vacancies again rise in the expanding sectors, but not by as much as they do when relative wages are constant. Workers now look more intensely for the unfilled jobs in the expanding sectors because of their higher expected earnings. Thus, although a given job vacancy will eventually be filled regardless of changes in relative wages, the job vacancy can be filled more quickly if the relative wage offered by the firm rises.

An influential study by the OECD (1965) concluded that in practice the sectoral allocation of labour is brought about through the quantity signals. The relative wage structure in manufacturing industries (for which comparable data are available) remains rigid in the face of big changes in employment shares. More recent work by the OECD (1985) has identified some changes in the industry wage structure of Member countries and some correlations between sectoral performance and sectoral wage change. But on the whole it did not overturn the results of the earlier study.

In a related study for Britain, Pissarides (1978) drew the distinction between the effectiveness of relative wage changes in bringing about employment change and the extent to which relative wages are used in order to speed up the relocation of labour. As in the OECD study, Pissarides found that relative wages in British manufacturing change by very little despite big changes in employment shares. However, even small changes in relative wages may be effective in bringing about big changes in employment shares. Thus, although relative wages may not change by much, they can contribute significantly to the sectoral allocation of labour.

These studies highlight an important issue relevant for markets with friction. Relative wages do not have to change in response to changes in relative labour requirements, as the allocation function can be done with quantities. But relative wages may change temporarily to speed up the adjustment or they may change permanently, with queues building up in the expanding sectors.

Although permanent change is not very likely, we argue in the next section that it is a possibility. What happens to relative wages in practice is, ultimately, an empirical question.

The purpose of this chapter is to examine this question for Great Britain in particular and compare these results with a similar empirical analysis of relative wages in the United States and Sweden. These two countries provide an interesting bench mark for comparison not only because of the availability of comparable data but also in the light of their very different economic systems. Wages in these three countries are determined under different institutional arrangements. Sweden and the United States are the two extremes. Sweden has very high union density and centralised bargaining. Union policy during negotiations has been dominated by the 'solidaristic wage policy' and the objective of wage equalisation across industrial groups. The explicit aim has been to rely on quantity signals and direct policy intervention to guide the sectoral reallocation of labour. Flanagan (1987) illustrates that relative wages have not been treated as a tool for the reallocation of labour in Sweden.

In contrast, the United States is very thinly covered by unions and no egalitarian objectives have entered into the wage negotiations. Wages are fixed mostly at the firm level and in principle one would expect them to reflect labour shortages. Of all the countries in our sample, the United States is the one most likely to exhibit relative wage flexibility and to rely on relative wages for the reallocation of labour.

Britain, as we illustrated in Chapter One, is heavily unionised but, in contrast to Sweden, wage negotiations are not centralised. Unions are largely organised on occupational lines and even appear to compete with each other to secure the highest wage rises for their members. However, the occupational form of organisation suggests that along the industrial dimension, wage flexibility may not be high.

Altogether we have comparable quarterly data for 41 industrial sectors from the three countries (8 from Sweden), drawn mainly from manufacturing and from some activities outside. We regress relative wages in each sector on some indices of sector performance (relative employment growth and relative productivity growth) and some indices of economy-wide performance (inflation change and vacancy or unemployment rates).

In the next two sections we discuss the theoretical ideas underlying our regressions. Our data and results are discussed in the sections that follow. Appendix A4.2 defines precisely the variables used in our regressions and gives the regression equation estimated in each of the 41 sectors.

4.2 The role of relative wages in sectoral adjustments

In order to analyse the question whether relative wages change in response to economic incentives, we acknowledge that wages may differ across sectors for 'equilibrium' reasons. We do not attempt to explain these determinants of wage differentials but to investigate their flexibility over time. We focus in particular on the influence of labour productivity, defined as output per employee, and on employment growth.

Our empirical approach can be motivated in terms of our theoretical discussion of Chapter One. A full empirical model would involve estimating at least a two equation model for each sector. However, at the sectoral level such estimation is over-ambitious. Furthermore, our main interest here is in the wage equation; the theoretical models of Chapter One and the empirical studies of the last two chapters are used as the background to justify the inclusion of the explanatory variables in our estimation.

We know from Chapter One that the firm's demand for labour can be derived from profit maximisation and gives labour demand as a positive function of output (or the capital stock), a negative function of the product wage, a positive or negative function of technical change (depending on the form that technical change takes and on the elasticity of substitution between factors), and possibly also as a function of other 'equilibrium' factors. Sectoral equations of this kind have been estimated for British industries by Nickell and Kong (1987).

The supply of labour to each sector is a little more complex, as now there is a sharp distinction between aggregate labour supply, which may be inelastic, and sectoral labour supply, which in the long run may be (and generally is) perfectly elastic. In the short run, and because of mobility costs associated with different skill requirements, information, physical considerations etc, there is strong inertia in the supply of labour to individual sectors. Workers move between sectors in response to differences in relative wages and relative job availability, but movement is slow. In order to provide the incentives to workers to move, expanding sectors have to offer either above-normal relative wages, or a more plentiful supply of jobs, or both. Because movement is slow, the relative position of an expanding sector may stay above normal for a long time - certainly long enough to be detected, say, in quarterly data. But when, as may happen in the long run, the distribution of labour across sectors matches the relative demand for labour in each sector, both sectoral wages and sectoral job availabilities need differ from the aggregate only by the 'compensating' margins that reflect the underlying attractiveness of each sector. If sectors are small compared with the economy as a whole, practically any distribution of sectoral demands for labour can be matched by supply at the compensating differentials; i.e. the sectoral supply of labour in the long run is perfectly elastic.

Thus, if we define equilibrium as the state where sectoral employment shares are unchanging, there is a clear demarcation in the roles of supply and demand in equilibrium. Supply conditions determine the distribution of wages and job availabilities (employment probabilities) through household preferences for work in each sector. Demand conditions influence only the distribution of employment across sectors. Big sectors are big because there is more demand for their product, not because they offer higher wages. They may have become big by temporarily offering higher wages and better chances of employment, but once they reach their desired size both their wages and job availability return to their compensating levels.

Now for employment shares to stay constant, relative productivity must also be unchanging, as productivity influences the demand for labour. If, as is normally the case, relative productivity and employment shares are changing, relative wages or relative job availabilities, or both, must reflect some influence besides compensating differentials. It is with these 'disequilibrium' influences on relative wages that we are concerned here.

Disequilibrium (meaning always non-compensating) differences in wages need not necessarily arise, despite changes in sector shares. The reason is that other factors, in particular changes in employment probabilities (as proxied, for example, by vacancy-unemployment ratios), can also induce sectoral employment change. Evidence for this was provided by Pissarides (1978) for industrial sectors in Britain. Both relative wages and relative vacancy-unemployment ratios induce sectoral mobility in Britain, so the adjustment of sectoral supplies to sectoral demands can be brought about through changes in relative vacancy-unemployment ratios, without changes in relative wages. The next section develops a formal model of sectoral adjustment. This model demonstrates that the same long-run equilibrium distribution of employment can be reached regardless of whether or not wages change during adjustment to reflect relative labour requirements.

This possibility leaves open the question of sectoral wage determination. Essentially what we need is a theory of wage determination that will tell us whether sectoral wages yield to the pressures of sectoral shifts in supplies and demand, even though they do not have to, or whether other considerations override supply and demand pressure. Such theory does not exist. What we have instead is a number of hypotheses about wage determination that imply certain independent influences on sectoral wages. What we intend to do here is to discuss briefly the main ones and derive their implications for the dependence of sectoral wages on sectoral productivities and employment shares.

4.3 Theoretical model and empirical framework

In this section we give a formal statement of the dynamic adjustments that take place at the sectoral level, following shocks to the sectoral demand for labour.

The firm's demand for labour in each sector i is derived from profit maximisation and can be written in log-linear form as

$$n_i^d = a_i - \alpha_i(w_i - p_i) - \beta_i(p_i - p) + z_i \qquad (4.3.1)$$

where n_i^d is (the log of) labour demand in sector i, a_i is an all inclusive variable representing productivity change and other 'equilibrium' influences on labour demand, w_i is the wage paid in sector i, p_i the price of output, p the general price level and z_i a shock to labour demand. A rise in the sector's relative price, $p_i - p$, reduces output demand, reducing the sectoral demand for labour at a given real wage. If firms are monopolistic competitors, the variable will enter their demand function, as in equation (4.3.1). But if they are perfect competitors it will not as the firm can then sell everything it wants at the sector price p_i. The inclusion or exclusion of this variable is not important for our results.

Supply to sector i is given by the dynamic equation

$$\Delta n_i^s = \gamma_i + \delta_i(w_i-w) + \epsilon_i(\theta_i-\theta) \qquad (4.3.2)$$

where n_i^s is the supply of labour to sector i, Δ is the difference operator, γ_i represents the 'compensating' differentials that exist in equilibrium because of underlying differences in the relative attractiveness of sectors, w is the aggregate wage rate, θ_i is the sector's excess demand position (e.g. vacancy-unemployment ratio) and θ is the average of the θ_i's. Nickell and Kong (1987) estimated equations like (4.3.1) for Britain and Pissarides (1978) estimated equations like (4.3.2), also for Britain.

Now suppose, without loss of essential generality, that

$$\theta_i = n_i^d - n_i^s, \qquad (4.3.3) \qquad (4.3.3)$$

and that the aggregate supply of labour is fixed at $\bar{n}$. Then, substituting from (4.3.3) into (4.3.2) we get

$$\Delta n_i^s = \gamma_i + \delta_i(w_i-w) + \epsilon_i(n_i^d-n_i^s-n^d+\bar{n}). \qquad (4.3.4)$$

Equation (4.3.4) is a dynamic equation in labour supply and equation (4.3.1) is an equation in labour demand that holds both during adjustment and in stationary equilibrium. These equations jointly determine supply and demand for given wages. To close the model we require a theory of wages; what is interesting here is that long-run equilibrium can be reached regardless of wage behaviour during adjustment.

To show this suppose for simplicity and without loss of essential generality that prices are fixed (e.g. by international competition), so let $p_i = p$ for all i. It is natural to define long-run equilibrium by equality between supply and demand in all sectors and by stationary shares, i.e.

$$n_i^d = n_i^s \text{ for all } i \tag{4.3.5}$$

$$\Delta n_i^s = 0 \text{ for all } i \tag{4.3.6}$$

Then 4.3.4 implies

$$w_i - w = -\gamma_i/\delta_i, \tag{4.3.7}$$

sectoral wage differentials compensate for the underlying attractiveness of sectors. Sectors with higher attractiveness, $\gamma_i > 0$, pay less than average in equilibrium.

Aggregate wages are determined by the condition that all the supply of labour is employed,

$$\Sigma n_i^d = \bar{n} \tag{4.3.8}$$

Substituting from (4.3.1) into (4.3.8) we get

$$\Sigma a_i - \Sigma\alpha_i(w_i-p) + \Sigma z_i = \bar{n} \tag{4.3.9}$$

In general equations (4.3.7) and (4.3.9) are solved for all the w_i. More simply, if α_i is independent of i, (4.3.9) is solved for $w(=\Sigma w_i)$ and then (4.3.7) gives the w_i. With knowledge of w_i, (4.3.1) gives employment in each sector. We adopt this simplification and write α_i without subscript, and write also a and z for the aggregate a_i and z_i. Then (4.3.9) implies

$$w - p = -(\bar{n}-a-z)/\alpha \tag{4.3.10}$$

and so from (4.3.7)

$$w_i - p = -(\bar{n}-a-z)/\alpha - \gamma_i/\delta_i. \tag{4.3.11}$$

Substituting into (4.3.1) we get employment in each sector

$$n_i = \bar{n} + a_i - a + z_i - z + \alpha\gamma_i/\delta_i \qquad (4.3.12)$$

Equation (4.3.12) implies that a structural shift in demands across sectors (change in z_i with z constant) reallocates labour across sectors one for one. But supply also has some influence on the equilibrium sectoral distribution of labour: more attractive sectors at given wages (γ_i higher) employ more labour.

Adjustment to the long-run equilibrium described by (4.3.11) and (4.3.12) can be brought about in a variety of ways. We consider two extremes, one where wages do not change at all and one where they change continuously to maintain equality between sectoral demands and supplies.

In the first case suppose all the w_i's are fixed by (4.3.11) throughout adjustment, i.e. (4.3.7) is satisfied and so (4.3.4) becomes

$$\Delta n_i^s = \epsilon_i(n_i^d - n_i^s - n^d + \bar{n}). \qquad (4.3.13)$$

Labour demand is given by (4.3.12), and aggregate labour demand is equal to aggregate labour supply by definition (though actual employment is in general less than both during adjustment, as there are unsatisfied excess demands in the expanding sectors). So (4.3.13) becomes, upon substitution of n_i^d from (4.3.12)

$$\Delta n_i^s = \epsilon_i(\bar{n} + a_i - a + z_i - z + \alpha\gamma_i/\delta_i) - \epsilon_i^s n_i. \qquad (4.3.14)$$

Equation (4.3.14) is a stable difference equation in sectoral labour supply. Supply in each sector tends to its long-run equilibrium monotonically because of the influence of excess demand on the cross-sectoral mobility of labour ($\epsilon_i > 0$).

As an alternative to fixed-wage adjustment, suppose supply and demand in each sector are always equal to each other during adjustment. Then omitting superscripts in (4.3.4) we get the sectoral change in employment

$$\Delta n_i = \gamma_i + \delta_i(w_i - w). \tag{4.3.15}$$

But from (4.3.1),

$$\Delta n_i = \Delta a_i - a\Delta w_i + \Delta z_i \tag{4.3.16}$$

so (4.3.15) becomes a difference equation in sectoral wages

$$\Delta w_i = (-\gamma_i + \delta_i w + \Delta a_i + \Delta z_i)/\alpha - (\delta_i/\alpha)w_i \tag{4.3.17}$$

During adjustment w is fixed by (4.3.10), as aggregate labour demand is always equal to aggregate labour supply, so (4.3.17) is stable and sectoral wages tend to their long-run equilibrium (4.3.11).

The two extreme cases that we considered illustrate the non-uniqueness of wages during adjustment. In the first case wages are unresponsive to demand shocks, yet employment adjustment is complete. In the second case, wages respond to sectoral shocks during adjustment. Employment adjusts to the same long-run equilibrium as before.

We have argued that in the long run, and if sectoral demands and supplies are competitive and equal to each other, sectoral wage differentials compensate workers for the nonpecuniary characteristics of their sectors. However, sectoral labour markets are frequently noncompetitive and this introduces the possibility of other influences on wages, even in long-run equilibrium. We mention two possible influences.

First, efficiency-wage considerations, which we surveyed in Chapter One, may influence the determination of wages. In this case sectoral wages are tied down by the incentives that employers want to offer to their employees. Then, if incentives differ across sectors, wages will also differ, and this may create 'equilibrium' excess demands or supplies in some sectors. Demand and supply may still have an influence on sectoral wages, but because now a third factor enters wage determination (incentives), wages may not be in compensating equilibrium even in the long run. In sectors where incentives are strong and wages high there will be excess supply of labour; conversely in other sectors. The 'involuntary' unemployment and vacancies will persist. Krueger and Summers (1988) and Katz (1986) have argued that the persistence of 'unexplained' wage differentials across industries is evidence in favour of efficiency wage influences on relative wages.

Another influence on wages in full equilibrium can be suggested by the bargaining approach. This approach, which we discussed in Chapter One, assumes that the firm and its workers bargain over wages because of local monopoly elements in labour markets. The agreed wage rate has both sectoral and economy-wide influences on it. The sectoral influences arise because sector performance influences the total revenue that the firm and its workers' share; the economy-wide influences arise because of their effect on the workers' alternative opportunities. However, Nickell and Kong (1987) show that if there are outside influences on wage bargains, they will dominate sectoral wage determination in the long-run. Thus in the long run they obtain an equation giving each sector's wage rate in terms of aggregate wages and possibly of other aggregate variables too.

To summarise the brief discussion of the long-run determination of sectoral wages, we have argued that in a competitive framework where sector demands are equal to sector supplies, sectoral wage differentials reflect only supply-side compensating influences. If efficiency-wage considerations are present, there are other influences on wages, with consequent excess supplies or demands in some sectors. But these other influences are not necessarily related to productivity or sector size. If explicit or implicit bargains under monopoly influence wages, some influences besides compensating differentials may still be present even in the long run. For example, the degree of unionisation of a sector and the openness of the sector to outside influences will influence the sector's wages. Productivity may also play a role, though not necessarily.

During adjustment the critical question is whether sectoral wages respond to the sectoral demand for labour in order to speed up the adjustment of supply, or whether they stay close to their long-run levels, leaving the burden of adjustment to relative excess demand. In each of the theories of long-run behaviour that we have outlined, employment adjustment to long-run equilibrium can be achieved without any wage adjustment. In the empirical work below we investigate whether there are short-run influences on wage differentials besides the long-run influences implied by each theory.

We investigate two important short-run questions. First, do firms in an expanding sector offer higher wages to attract labour faster? For this we need a measure of the strength of the sectoral demand for labour. In our empirical work we use two measures, the relative size of the sector. We interpret both these measures as proxies for an exogenous rise in demand. Although themselves endogenous, our interest is in whether relative wages are used as a recruitment tool: both higher relative vacancies and growth in relative size indicate faster relative recruitment in the sector in question. As we saw in our discussion of the theory, short-run changes in relative size are due to exogenous labour demand shocks, as sectoral labour supply shocks are not likely to be important in the short-run (e.g. workers are not likely to change their taste for particular types of work within short periods of time).

Although as we have already stressed there is no need for wages in expanding sectors to rise, we would expect them to do so (at the very least) in cases where wages are determined competitively. Also, if firms fix wages as monopsonists they may raise them when wanting to recruit more labour. But if, say, wages are determined by bargains with the existing labour force and recruitment from outside at the going wages is easy, wages are less likely to respond to changes in size.

The second question that we investigate is whether wages are related to labour productivity, measured as output per employee. This would be implied, for example, by a model where wages are determined by bargains between employed workers and firms. Productivity gains are shared between the firms and its workers in such a situation, especially in the short run. In the long run, and if outsiders have any influence on the wage bargain, through unions for example, the influence of productivity on wages may be lost (Nickell and Kong, 1987).

In addition to these questions, we investigate whether sectoral wage differentials respond to aggregate cyclical shocks. This would be the case if different sectors used different methods of determining wages: competitive wages are more likely to be cyclical than efficiency wages or bargain outcomes. We proxy cyclical shocks by two variables, first the vacancy rate in the European countries under study and the aggregate unemployment rate in the US, and second the change in the inflation rate. We consider the vacancy rate to be a better measure of aggregate cyclical conditions but the unavailability of a series for it in the US forces us to use the unemployment rate. If relative wages responded to aggregate shocks there could be cyclical misallocations of relative labour supply, as workers try to move to high-wage sectors to take advantage of the cyclical benefits.

4.4 Empirical results

A full listing of our data and their sources are given in Appendix A4.2. In Table 4.4.1 we list the sectors used in our analysis with their number and symbol, used to identify them in the Tables of the next section.

In terms of size, the sectors vary widely. The Swedish data are dominated by a huge sector, fabricated metals, which accounts for more than half the employment in our sample. The rest of the sectors are of approximately equal size, except for the smallest, mining and quarrying. The British data are distinguished by a moderately big engineering sector but with the exception of engineering and construction the other sectors are small, with a share of less than 10 per cent each. The US sectors are more uniform in terms of size than the sectors of the other countries, though variations do exist because of a large number of small sectors.

The variables we use in our analysis are straightforward. For the two European countries we estimate equations for relative hourly earnings in terms of relative productivity, employment share, relative vacancy rates, aggregate vacancies, inflation and lagged values of the dependent variable. For the United States we do not have vacancy or unemployment data for individual sectors so we use the aggregate unemployment rate in place of the vacancy rate. A summary of the results is given in Tables 4.4.2 and 4.4.3. The results for each country are compared with a naive autoregressive specification for relative hourly earnings. The results of the F test for the exclusion of all regressors other than the lagged dependent terms and the relative wage are also given in the Tables.

Table 4.4.1

Sectors used in the analysis for Sweden

			Mean employment, 000s	Share
1.	MQ	Mining and quarrying	14.9	1.7
2.	FR	Food products	85.4	9.9
3.	WP	Wood products	84.8	9.8
4.	PP	Paper products	63.4	7.3
5.	CH	Chemicals	73.0	8.4
6.	NM	Non-metallic minerals	31.7	3.6
7.	BM	Base metal industries	62.8	7.7
8.	FM	Fabricated metal products	452.3	52.1
		Total	868.3	100.0

Sectors used in the analysis for Britain

1.	FC	Food, drink and tobacco	718.8	7.8
2.	CC	Coal, petroleum chemical etc	469.8	5.1
3.	MM	Metal manufacture	514.2	5.5
4.	EN	Engineering & electrical goods	1983.5	21.0
5.	SM	Shipbuilding & marine engineering	178.6	1.9
6.	VE	Vehicles	771.1	8.4
7.	MG	Metal goods - other	551.7	6.0
8.	TX	Textiles	553.3	6.0
9.	LF	Leather, leather goods & fur	44.3	0.5
10.	CF	Clothing and footwear	405.8	4.4
11.	BP	Bricks, pottery, glass, cement	286.0	3.1
12.	TF	Timber, furniture, etc	260.2	2.8
13.	PP	Paper, printing & publishing	571.0	6.2
14.	OM	Other manufacturing industries	311.7	3.4
15.	CN	Construction	1328.1	14.1
16.	GE	Gas, electricity and water	367.6	4.0
		Total	9225.8	100.0

Sectors used in the analysis for the USA

1.	PM	Primary metal industries	1162	7.2
2.	FM	Fabricated metal products	1407	9.0
3.	MA	Machinery, except electrical	1853	11.8
4.	EE	Electrical & electronic equip't	1691	10.8
5.	TX	Textile mill products	941	6.0
6.	CH	Chemical products	939	6.0
7.	PC	Petroleum & coal products	204	1.3
8.	RP	Rubber & plastic products	543	3.4
9.	LW	Lumber & wood products	700	4.5
10.	SC	Stone, clay & glass products	620	4.0
11.	TB	Tobacco manufactures	84	0.5
12.	AP	Apparel products	1272	8.1
13.	PP	Printing and publishing	1046	6.7
14.	LE	Leather products	310	2.0
15.	FF	Furniture and fixtures	418	2.6
16.	TE	Transportation equipment	1841	11.8
17.	PA	Paper products	636	4.1
		Total	15667	100.0

TABLE 4.4.2

Significant Sectors in Each Country

(Sector number as in Table 4.4.1)

sectors	Sweden (8)	Britain (16)	USA (17)
Lagged dependent[1] variable	3,4,6,8	1,2,5,8, 9,10	3,4,5,6,7,9,10 11,13,15,16
Relative wages ≠ 0	All but 4,6,7	All but 10,12	All but 1,6,9,11,13, 14,17
Relative wages ≠ -1	All but 2,3,7	All but 2,11,16	All but 5
Relative productivity	2,3	4,8,13,16	1,5,7*,8*
Change in relative productivity	2,8	12,15,16	8,12
Employment share	2,3,5,6*	2,4,9,12,16	1,2*,5,8,14
Change in employment share	6*,8*	1*,8,12,13,16	3,7,9,11*
Relative vacancies	6,8*	2*,8*,11*,12*	
Vacancies[2]	2,3,5,8	4	5,12,14,15
Change in unemployment			1,4,7,17
Change in inflation	8	4,9,14	1,2,3,4,5,6,8, 9,12,14,17
F-test[3]	2,3,8	2,8,12,13,16	1,2,3,4,5,6,7, 8,9,12,14,17

Notes:

The Table gives for each variable the sector number where a significant estimate was obtained at the 10% level. An asterisk indicates that the estimate was incorrectly signed. The Error

Correction Model estimated is given in Appendix A4.1. The dependent variable is the change is the log of the sector's relative wage and the regression includes also constant, seasonal dummies and three lagged dependent variables. The sample is quarterly for the following periods:

Sweden, 1975Q2 - 1986Q2; Britain, 1964Q2 - 1982Q4;

USA, 1964Q2 - 1986Q4.

1. Sector listed when at least one of the lagged dependent terms is significant.
2. For USA total unemployment rate is used instead of vacancies which are not available.
3. F-test for the exclusion of the seven economic variables following relative wages. The reported sectors are those for which exclusion is rejected (i.e. the F-statistic is significant).

The change in each sector's employment share and (in the European countries) the sector's relative vacancy rate are entered as proxies for the sector's relative labour requirement. Employment share is entered also in level, since with quarterly data and if labour mobility is slow, the first difference may not pick up the general trend of the change in the sector's size. Relative productivity is defined as the average of the previous four quarters and it is also entered in both level and first difference, for similar reasons. The other independent variables - change in aggregate wage inflation and the aggregate vacancy rate in the two European countries, and change in aggregate wage inflation, the aggregate unemployment rate and the change in the unemployment rate in the United States - are entered to capture any differences in the responses of sectoral wages to cyclical shocks, even if the shocks affect all sectors. The change in the vacancy rate was tried in the European regressions but it was left out of the final regressions because it was insignificant everywhere. The full specification of the estimated regressions is given in Appendix A4.1.

Because of the large number of sectors in our analysis (41 altogether) we estimated the same specification of the equation everywhere. We did not try to find the 'best' specification for particular sectors or countries, though undoubtedly improvements in some sectors can be made. Thus when evaluating the results the caveat should be borne in mind that the differences found between countries may be due to differences in the appropriate specification (eg. in the number of lags), though we shall generally attribute them to differences in the overall effect of the explanatory variables on relative wages. Our regressions are particularly well suited for inter-country comparisons, the aspect of the results that we emphasise.

Giving the estimate and standard error of each estimated coefficient would not be of much use in the present discussion, so we report selectively some of the results. Table 4.4.2 gives the number of each sector, as defined in Table 4.4.1, for which the estimated coefficient on the variable listed is significant at the 10 per cent level. The table gives also the significance for the F-test, for the exclusion of all non-wage variables. The dependent variable is the change in the log of hourly earnings of the sector in question relative to all other sectors in the country's sample (i.e. it is the sector's relative wage growth). There are three lags of the dependent variable on the right-hand side and there is also the level of the relative wage, lagged one quarter. The first row of Table 4.4.2 gives the number of each sector where at least one of the lagged dependent terms is significant. The second and third rows give the sector numbers for which the coefficient on the relative wage is significantly different from zero or from one. If the coefficient is significantly different from zero, the equation can be rewritten as a relative wage equation, with a unique long-run solution. If in addition the coefficient is significantly different from (minus) one, adjustment to the long-run level is lagged and takes four quarters or more. Otherwise adjustment is completed before the end of the year. If the estimated coefficient on the lagged relative wage is zero, we have an equation in the first difference of the relative wage, without convergence. This could indicate, for example, that relative wages are a random walk, which is not implausible if the innovations are small, as they are in all our regressions.

Table 4.4.3 gives the estimated coefficients, when they are significantly different from zero at the 10 per cent level. These equations have the level of the relative wage on the left-hand side and the economic variables on the right-hand side, and they are derived by rearranging the wage terms in the estimated regressions summarised in Table 4.4.2. The diagnostics and F-tests reported are the ones of the estimated regressions, with the change in the relative wage as the dependent variable.

It is helpful to begin by looking at the standard deviations and diagnostics in Table 4.4.3. For Sweden, we find that the standard deviations of relative wages are extremely small. Only two sectors, mining and quarrying and paper products, with a total employment share of less than 10 per cent, have standard deviations exceeding 2 per cent. Thus, in Sweden there is not much variation in relative wages to explain. The weighted average of the standard deviations (with employment shares as weights) is a mere 1.35 per cent. However, our regression explain a good proportion of the variation in relative wages. The tests for first-order autocorrelation, LM(1), and for autocorrelation up to the fourth order, LM(4), pass in all sectors, except for LM(4) in the final sector.

The weighted average of the British standard deviations is 3.1. The regressions are significant in all cases and the LM test for autocorrelation fails to reject it only in two sectors.

In the United States fluctuations in relative wages are again high, with a weighted average of the standard deviations of 3.5 per cent. The regressions here explain a bigger fraction of the variance than in the other countries, though six out of the 17 sectors fail one of the LM tests for autocorrelation.

Thus, in terms of the standard deviations of relative wages we find that Sweden is the exception, with much smaller standard deviations than in the other countries. The regressions are significant everywhere: in Britain and Sweden it is satisfactory and in the United States adequate.

The most interesting test-statistic for our purposes is the F statistic that tests for the exclusion of the 'economic' variables from the regression. The results of this test are shown in the bottom row of Table 4.4.2 and the calculated value of F is given in Table 3.

In Sweden three of the eight sectors have significant Fs, including the big fabricated metals sector. In Britain performance is again similar, with six significant out of 16. In Britain about 30 per cent of the labour force is employed in sectors with significant Fs. In the United States significance is altogether higher, with 12 out of 17 sectors having significant Fs. The sectors with significant Fs employ about 75% of the labour force, which exceeds even Sweden's 72 per cent (though this measure for Sweden is not very meaningful because 52 per cent is accounted for by a single sector). Thus, the message that the F tests tell is that in the United States relative wages respond more to economic performance than they do in Europe. The two European countries exhibit similar performance on this criterion.

Closer examination of the Swedish results shows that relative wages in two sectors, food products and wood products, can be said to respond to indices of sector performance. Both relative productivity and employment share influence relative wages significantly. Moreover, although the magnitude of the influence is small, adjustment in wages is completed within the year (see the level regressions in Table 4.4.3). Relative wages in these two sectors exhibit also cyclical behaviour apparently unrelated to sector performance, as the significance of aggregate vacancies indicates. Relative wages for food products are procyclical whereas for wood products they are counter-cyclical.

Apart from these two sectors, however, there are some isolated significant estimates that do not dominate a single autoregressive specification for relative wages, and there is also overall significance in the largest sector, where as it turns out, two of the three important coefficients are incorrectly signed. In sector 8, only the change in relative productivity has the predicted positive effect. There is also some cyclicality in this sector's relative wages, as shown by the significance of both aggregate vacancies and the change in inflation.

In Britain relative vacancies are either insignificant or wrongly signed everywhere. Cyclicality in the data is less frequently observed than in the other countries, so in the small number of sectors where the autoregressive specification does not do well there are sector-specific influences on relative wages. Thus, relative productivity is significant and correctly signed in six sectors and employment share in seven sectors. This is more supportive of the view that sector wages reflect sectoral performance than in our Scandinavian country, Sweden. However, it is only a minority of the sectors that exhibit sectoral influences of any kind. There is overall significance of the sectoral variables in only four sectors (8, 12, 13, 16) and near-significance in the big engineering sector. This is the same order of overall performance of the sectoral variables as in Sweden. There is partial adjustment of relative wages in Britain almost everywhere.

The results for the United States strongly support the view that relative wages are subject to cyclical influences. Sectoral variables perform poorly in the vast majority of sectors. Relative productivity or its first difference is incorrectly signed in two sectors and only four out of 34 estimated coefficients on relative productivity or its first difference are significant and of the predicted sign. Employment share does better, with seven coefficients correctly signed, two incorrectly signed and 25 not significantly different from zero. By contrast, the change in wage inflation is significant in 11 sectors and unemployment or its change in 8.

Thus relative wages in the United States are better explained by our regressions than in the European countries but only because of the influence of the aggregate variables. This influence is not related to changes in sectoral demands, and hence to sectoral labour requirements, unless one believes that aggregate inflation and unemployment are driven by sectoral shocks. Lilien (1982) put this view forward for the United States, but as Abraham and Katz (1986) have argued, the correlation is more likely to be reversed: aggregate shocks that cause cyclical fluctuations in aggregate variables affect individual sectors at different speeds and to different degrees. The discussion so far in the literature has been in terms of sectoral employment change. Our evidence shows that sectoral wages are also influenced non-uniformly by aggregate shocks over the cycle. The existence of overlapping nominal contracts in most of US manufacturing could explain this pattern, as sectors respond at different times to observed changes in inflation and unemployment (see Taylor 1980). Their absence in Europe could also explain why we have failed to find as much cyclicality in relative wages in the European countries as we found in the United States.

In terms of relative productivity and employment share, performance in the United States is of about the same order of magnitude as in Europe, with about one third of the sectors showing significant sector influences. As a further test of sectoral influences in the United States, and given the absence of sectoral vacancies, we tried sctoral inventory holdings. We have quarterly inventories for eight of the 17 sectors in our sample. A rise in inventory holdings in one sector over and above holdings in other sectors indicates that the sector needs to recruit less labour, since production exceeds sales. In three of the nine sectors (2, 3, 8) we find a significant negative coefficient on the sector's relative inventory holding, where we include it in the list of regressors. But in three other sectors (1, 6, 7) we find a significant positive coefficient and in the other two sectors (4, 5) no significant effect at all. Thus, although there is evidence of flexibility of relative wages with regard to inventory holdings, there is no strong evidence that sectors with above normal inventory holdings reduce their relative wage rate.

4.5 Concluding remarks

The hypotheses that we have examined are whether relative industrial wages fluctuate in response to economic change and whether, when they do, they reflect sectoral performance and labour requirements. Our methodology and main results were set out in the Introduction. We estimated altogether 41 regressions for relative industrial wages in three countries. Sweden exhibits the least relative wage flexibility. In none of the three countries do sectoral variables influence much sectoral wages. The United States is the only country where in a large number of sectors relative wages respond significantly to economic variables, but most of the response is to aggregate cyclical variables and the response to some of the sectoral variables is incorrectly signed.

In short, our main conclusions are three: firstly, in terms of fluctuations in relative wages, the three countries fall into two groups, on the one hand Sweden with very little fluctuation and on the other the UK and the US with more fluctuations of a similar order of magnitude. Secondly, sector variables influence sector wages in one quarter to one third of the sectors. Performance in the three countries is comparable in this respect. Lastly, relative wages in the United States respond more to the economic variables in our study than do relative wages in the two European countries. However, statistically the most important variables in the regressions are indices of economy-wide cyclical performance, not indices of sector performance.

Undoubtedly improvements to our study can be made. In some of the sectors the common dynamic specification that we have imposed is clearly inadequate. We have allowed for unrestricted lags of up to a year, which proved satisfactory for Sweden and Britain, but in some US sectors there is evidence of dynamic misspecification. More disaggregated data - especially for Sweden where more than half of the labour force in the sample is employed in a single sector - may also shed more light on the issue.

TABLE 4.4.3

Estimated Effects on Relative Hourly Earnings*

(a) SWEDEN

	MQ (1)	FP (2)	WP (3)	PP (4)	CH (5)	NM (6)	BM (7)	FM (8)
Sum of lagged coefficients	0.71 (4.44)	-	-	0.90 (5.32)	0.49 (2.54)	0.56 (1.90)	0.50 (1.52)	0.73 (5.34)
Relative productivity	-	0.22 (4.20)	0.13 (4.78)	-	-	-	-	-
Change in relative productivity	-	0.64 (6.79)	-	-	-	-	-	0.31 (2.39)
Employment share	-	0.20 (3.55)	0.06 (2.31)	-	0.08 (1.81)	-0.08 (2.32)	-	-
Change in employment share	-	-	-	-	-	-0.15 (2.71)	-	-0.31 (2.26)
Relative vacancies	-	-	-	-	-	0.01 (2.15)	-	-0.01 (2.28)
Vacancies	-	0.62 (2.41)	-0.58 (2.85)	-	0.64 (1.74)	-	-	-0.74 (2.50)
Change in inflation	-	-	-	-	-	-	-	-0.14 (3.05)
S.E.	0.014	0.007	0.006	0.014	0.011	0.010	0.009	0.007
Std. Dev. of Dependent	0.028	0.012	0.011	0.027	0.015	0.012	0.012	0.012
LM(1)[1]	0.66	1.90	1.77	0.88	6.10	0.34	1.62	1.31
LM(4)[2]	0.98	1.96	2.11	1.36	2.25	1.87	1.14	3.42
F(7,30)[3]	1.45	7.62	4.53	1.50	0.81	2.02	1.03	2.40

Notes

* Coefficient estimates from the error-correction model given in Appendix A4.1, with the level of the relative wage as dependent variable. Estimates not significant at 10% level or better indicated by dash. Sector symbols and numbers as in Table 1.

1. F test (LM) for first-order autocorrelation, critical value at 5% level:

Sweden	4.18
Britain	4.00
USA	3.98

2. F test (LM) for autocorrelation up to fourth order, critical value at 5% level:

Sweden	3.01
Britain	2.60
USA	2.58

3. F test for the exclusion of the seven non-wage economic variables. Critical value at 5% level:

Sweden	2.33
Britain	2.33
USA	2.13

4. Chow tests for parameter changes four and eight quarters before the end of each sample rejected at 5% in all cases.

(b) BRITAIN

	FD (1)	CC (2)	MM (3)	EN (4)	SM (5)	VE (6)	MG (7)	TX (8)
Sum of lagged coefficients	0.48	–	0.50	0.58	0.69	0.74	0.81	0.66
	(1.92)		(3.13)	(3.79)	(5.75)	(6.73)	(8.18)	(5.08)
Relative productivity	–	–	–	0.09	–	–	–	0.08
				(1.77)				(1.95)
Change in relative productivity	–	–	–	–	–	–	–	–
Employment share	–	0.15	–	0.11	–	–	–	–
		(2.07)		(1.97)				
Change in employment share	–0.52	–	–	–	–	–	–	0.73
	(1.82)							(2.89)
Relative vacancies	–	–0.06	–	–	–	–	–	–0.04
		(2.46)						(2.32)
Vacancies	–	–0.03	–	0.01	–	–	–	–
		(3.35)		(1.78)				
Change in inflation	–	–	–	–0.11	–	–	–	–
				(2.04)				
S.E. 4	0.020	0.017	0.022	0.011	0.033	0.025	0.013	0.01
S.D. of Dependent 7	0.030	0.028	0.025	0.017	0.044	0.046	0.024	0.02
LM(1)[1]	0.32	4.33	0.66	0.78	1.16	1.66	2.29	0.28
LM(4)[2]	0.81	1.48	0.91	3.17	1.34	0.41	1.58	0.23
F(7,60)[3]	1.47	4.24	1.41	2.01	0.81	1.70	1.23	2.34

(b) BRITAIN

	LF (9)	CF (10)	BP (11)	TF (12)	PP (13)	OM (14)	CN (15)	GE (16)
Sum of lagged coefficients	0.64 (4.03)	0.88 (11.13)	0.43 (1.30)	0.86 (6.83)	0.87 (8.70)	0.56 (2.80)	0.62 (3.48)	-
Relative productivity	-	-	-	-	0.22 (2.21)	-	-	0.27 (2.73)
Change in productivity	-	-	-	0.35 (2.15)	-	-	-0.73 (2.58)	0.99 (1.72)
Employment share	0.17 (1.85)	-	-	0.17 (2.45)	-	-	-	0.46 (2.33)
Change in employment share	-	-	-	0.42 (2.42)	0.67 (1.81)	-	-	1.81 (3.11)
Relative vacancies	-	-	-0.02 (1.78)	-0.03 (1.89)	-	-	-	-
Vacancies	-	-	-	-	-	-	-	-
Change in inflation	-0.20 (1.81)	-	-	-	-	-0.23 (3.40)	-	-
S.E.	0.021	0.016	0.012	0.017	0.016	0.013	0.029	0.041
S.D. of Dependent	0.055	0.045	0.015	0.034	0.034	0.015	0.040	0.072
LM(1)[1]	0.22	0.59	0.08	0.52	0.07	0.17	0.10	0.29
LM(4)[2]	1.52	0.66	0.40	2.19	0.76	1.81	1.76	0.84
F(7,60)[3]	1.80	1.31	1.03	2.46	3.45	2.25	1.95	4.17

(c) USA

	PM (1)	FM (2)	MA (3)	EE (4)	TX (5)	CH (6)	PC (7)	RP (8)
Sum of lagged coefficients	0.96 (25.95)	0.59 (4.21)	0.82 (8.28)	0.96 (12.15)	0.46 (3.29)	0.75 (18.75)	0.61 (3.74)	0.67 (5.78)
Relative productivity	0.04 (2.27)	-	-	-	0.08 (2.48)	-	-0.10 (1.82)	-0.06 (1.90)
Change in relative productivity	-	-	-	-	-	-	-	-0.18 (1.89)
Employment share	0.04 (2.50)	-0.05 (2.10)	-	-	0.05 (2.12)	-	-	0.32 (8.93)
Change in employment share	-	-	0.08 (2.22)	-	-	-	0.14 (1.78)	-
Unemployment	-	-	-	-	-0.04 (3.98)	-	-	-
Change in unemployment	-0.04 (2.00)	-	-	0.04 (2.43)	-	-	0.16 (2.04)	-
Change in inflation	-0.47 (4.56)	-0.21 (3.48)	-0.35 (5.14)	-0.28 (3.16)	-0.24 (1.96)	-0.32 (4.07)	-	-0.43 (4.45)
S.E.	0.010	0.006	0.006	0.009	0.012	0.007	0.036	0.010
S.D. of Dependent	0.061	0.010	0.013	0.016	0.021	0.036	0.072	0.038
LM(1)[1]	2.22	2.74	8.18	4.14	0.55	3.75	1.86	2.79
LM(4)[2]	1.33	1.63	5.04	3.39	0.98	1.73	2.56	1.22
F(7,68)[3]	5.56	3.17	6.83	3.77	5.01	4.52	2.18	18.5

(c) USA

	LW (9)	SC (10)	TB (11)	AP (12)	PP (13)	LE (14)
Sum of lagged coefficients	0.71 (14.79)	0.45 (2.37)	0.66 (10.65)	0.84 (13.13)	0.85 (7.02)	0.94 (15.93)
Relative productivity	-	-	-	-	-	-
Change in relative productivity	-	-	-	0.17 (1.90)	-	-
Employment share	-	-	-	-	-	0.02 (2.05)
Change in employment share	0.10 (2.34)	-	-0.11 (2.58)	-	-	-
Unemployment	-	-	-	-0.03 (3.42)	-	-0.01 (2.82)
Change in unemployment	-	-	-	-	-	-
Change in inflation	-0.40 (4.08)	-	-	-0.45 (4.40)	-	-0.47 (5.31)
S.E.	0.009	0.027	0.024	0.010	0.032	0.007
S.D. of Dependent	0.035	0.031	0.143	0.063	0.055	0.064
LM(1)[1]	1.22	3.28	0.51	6.49	6.46	6.48
LM(4)[2]	1.40	1.04	0.40	2.29	3.25	3.02
F(7,68)[3]	4.71	0.87	1.46	6.27	0.58	8.51

(c) USA

	FF (15)	TE (16)	RP (17)
Sum of lagged coefficients	0.60 (4.38)	0.54 (3.00)	0.91 (35.00)
Relative productivity	–	–	–
Change in relative productivity	–	–	–
Employment share	–	–	–
Change in employment share	–	–	–
Unemployment	-0.04 (2.69)	–	–
Change in unemployment	–	–	0.02 (1.82)
Change in inflation	–	–	-0.34 (5.34)
S.E.	0.018	0.034	0.005
S.D. of Dependent	0.036	0.046	0.041
LM(1)[1]	1.28	0.35	6.66
LM(4)[2]	1.10	0.33	3.58
F(7,68)[3]	1.53	1.42	6.22

Appendix A4.1

The basic Error Correction Model estimated for Sweden and Britain is given below:

$$\Delta(\ln w_i - \ln w_{(i)}) = \alpha_0 + \sum_{j=1}^{3} \alpha_j \Delta(\ln w_i - \ln w_{(i)})_{-j} + \alpha_4 \Delta^2 (\ln w_{(i)})_{-1} +$$

$$\alpha_5 \Delta\Big[\ln(y/n)_i - \ln(y/n)_{(i)}\Big]_{-1} + \alpha_6 \Delta \ln(n_i/n)_{-1} +$$

$$\alpha_7 (\ln w_i - \ln w_{(i)})_{-1} + \alpha_8 (\ln v_i - \ln v_{(i)})_{-1} + \alpha_9 (\ln v_{(i)})_{-1} +$$

$$\alpha_{10}\Big[\ln(y/n)_i - \ln(y/n)_{(i)}\Big]_{-1} + \alpha_{11} \ln(n_i/n)_{-1}$$

Since no sectoral vacancy or unemployment data are available for the US, we used the log of the total unemployment rate instead of vacancies in the US regressions. The change in unemployment was also used as an independent variable in the US regressions.

Appendix A4.2

Data definition and sources:

(a) Sweden

Source: Allman Manadasstatistik 1987 Supplement, quarterly data, 1974Q1–1986Q2.

n_i Employment in industry i.

V_i Vacancies in sector i.

w_i Average hourly earnings in industry i.

y_i Index of production in industry i, 1980=100.

(b) Britain

All quarterly data, 1963Q1–1982Q4 (SIC 1968 lectures).

n_i Employees in employment, in sector i, end of quarter. Table 1.2 of Department of Employment (DE) Gazette.

V_i Vacancies in sector i. End of quarter data up to the second quarter of 1976. Quarterly data from 1976Q3 onwards. Source: Table 3.3 of the DE Gazette.

w_i Average hourly earnings. End of quarter data all employees. Table 5.3 of DE Gazette. Series for sectors CC and EN were obtained from the data on their component SIC orders (IV and V; VII, VIII and IX respectively) using employment as weights.

y_i Quarterly data of the Index of Industrial production. Monthly Digest of Statistics (MDS) Table 7.1.

(c) USA

Source: Business Statistics 1979, 1984 and Survey of Current Business April 1987, quarterly data, 1963Q1-1984Q4.

I_i Book value of inventories at the end of the period in industry i.

n_i Employees on the payroll of industry i.

u Unemployment rate.

w_i Average hourly earnings for production workers in industry i.

y_i Index of production in industry i, 1977=100.

The following variables were constructed from the above data:

$I_{(i)}$ Weighted average of inventories in all sectors but i:

$$I_{(i)} = \frac{\sum_{j \neq i} I_j n_j}{\sum_{j \neq i} n_j}$$

v_i Sectoral vacancy rate:

$$v_i = \frac{V_i}{n_i}$$

$v_{(i)}$ Vacancy rate in all industries but i:

$$v_{(i)} = \frac{\sum_{j \neq i} v_j}{\sum_{j \neq i} n_j}$$

$w_{(i)}$ Weighted average of hourly earnings in all industries but i:

$$w_{(i)} = \frac{\sum_{j \neq i} w_j n_j}{\sum_{j \neq i} n_j}$$

$(y/n)_{(i)}$ Output per person (productivity) in all sectors but i:

$$(y/n)_{(i)} = \frac{\sum_{j \neq i} y_j}{\sum_{j \neq i} n_j}$$

The measure of relative productivity used in the regressions, $[\ln(y/n)_i - \ln(y/n)_{(i)}]$, is smoothed; it is the simple arithmetic average of the previous four quarters. Current values were omitted to avoid endogeneity problems.

Chapter Five

Wage Determination: An Assessment of Returns to Education, Occupation, Region and Industry

Evidence from the Family Expenditure Survey, 1978 - 1985

5.1 Introduction

In the preceding chapters we looked at wage determination at the aggregate level and at the industry level both for the United Kingdom and a number of other industrial economies. Such aggregate studies are instructive in that not only do they provide the determinants of average earnings through time but also explain a good deal of the short-run variation in earnings. These studies also present us with a few suggestions regarding the likely impact of macroeconomic policy on the labour market in each individual country.

However, as we pointed out in chapter 2, although there is general agreement about the theoretical framework within which wages are determined, there is no agreement among scholars when it comes to empirical studies. This lack of harmony in time series work encourages us to also look at cross-section work in search of consensus.

Furthermore, studies at the aggregate level conceal the degree of variation in earnings in the economy. There are enormous disparities in pay for those working in different industries, occupations and regions. Individual characteristics such as sex, education, experience, marital status and race have been widely examined in the cross-section literature on wage determination and found to influence the variation in pay. For instance, Stewart (1983) estimates individual earnings equations for manual male employees in manufacturing using the 1975 National Training Survey in order to examine union/non-union wage differentials. He finds that human capital variables representing individual attributes such as the experience profile and the level of education, as well as variables representing job characteristics, significantly influence individual earnings.

A cross-section study on its own cannot tell us about the importance of such determinants of the variation in pay through time, which has been the focus of this thesis so far, nor can it provide a harmonizing framework for time series work. However, there are a number of annual surveys in the United Kingdom which contain information on pay as well as its determinants. A study providing a time series of cross-section wage equations from any of these surveys will furnish us with invaluable evidence both on the determinants of wages at the individual level and their variation over time.

In chapter 4 we examined the structure of relative industrial earnings. This study revealed the diverse structure of wage determination among different industries. Any shift in the industrial structure would have at least a short-run impact on average earnings in the economy.

Regional variation in pay is another feature which is difficult to deal with in aggregate studies. According to the 1985 New Earnings Survey, construction workers in the South East were paid on average £171 whereas those in East Anglia received £151 and those in the South West earned merely £141. Such variations of more than 20 per cent in pay in three neighbouring regions point to the necessity of learning more about regional wage differentials.

Between 1980 and 1985, consumer prices in the UK rose by 36 per cent while average earnings surged some 63 per cent. One may ask: can the upsurge in wage inflation be explained, at least in part, by a change in the regional, industrial or occupational pattern of wages?

Individual level data can also help us to understand issues which are difficult to deal with at the aggregate level. In chapter 3 we presented some illustrative, and by no means conclusive, evidence regarding the problem of skill shortages. Given the availability of individual level data there are at least two ways to investigate the influence of skill shortages on wage inflation. Firstly, one could estimate a time series of cross-section wage equations, control for occupational categories and then examine the change in the occupational wage differentials. Alternatively, one could construct a panel or a pseudo-panel, as suggested by Deaton (1985), from individual level data and estimate a change in wages equation, controlling for changes using a suitable index of demand for occupational categories such as occupational vacancy rates.

Other variables influencing the diversity in pay are human capital measures such as education and experience. A time series of cross-sections using individual level data not only allows us to measure the returns to education, an interesting issue in itself, but also to inquire whether demographic changes or changes in the occupational or industrial mix of jobs in the economy have altered the returns to education.

The idea of estimating a time series of cross-sections is by no means new. Gomulka and Stern (1986) successfully explain a good deal of the increase in the proportion of married women in employment between 1970 and 1983 by estimating a time series of cross-sections from the Family Expenditure Survey.

For our purposes, there are three sources of survey data containing information on pay and its determinants available for the United Kingdom on an annual basis. The most obvious choice for income data is the New Earnings Survey. Unfortunately, this data set is not readily available in the public domain, and although the Department of Employment is prepared to run regressions on this data on behalf of academics (a very time consuming and expensive procedure), they are, by law, prevented from releasing the data for "hands on" academic work. The other two options are the General Household Survey, (GHS), and the Family Expenditure Survey, (FES). The main problem with the GHS is that it is rather poor on income data compared to the FES which provides details of all the constituent elements of income. More seriously for our purposes, the design of the GHS changes each year, making it difficult to trace through the change in the parameters of a comparable set of variables over a number of years. For instance, the industry code applied to each individual's occupation is sometimes given at the two-digit level and sometimes just at the one-digit level.

The data for the work presented here come from the Family Expenditure Survey. The FES is available annually from 1970, although the education variable is only available from 1978. The FES has established a high reputation for the quality of its data collection, processing and documentation. More importantly, the data are collected on a consistent basis across the years. The data provide a very good set of household and individual characteristics as well as detailed income and expenditure records.

Before we embark upon estimation, a brief survey of the theory of wage determination at the individual level is presented in Section

5.2. The description of the data is provided in Section 5.3. The econometric model is presented in Section 5.4 and our empirical findings are put forward in Section 5.5. In the final Section, 5.6, we present a few concluding remarks.

5.2 Theoretical framework

This section is devoted to the exposition of the theory of wage determination at the individual level with the aim of providing a framework for empirical analysis. The theoretical work in this area is very much associated with the human capital literature; Mincer (1962, 1974) and Becker (1964, 1975) stand out as pioneering landmarks in the development of the human capital earnings function.

Formal theoretical human capital models of life cycle earnings such as Ben-Porath (1967) assume that the individual maximises the present discounted value of life time earnings subject to a human capital production function; life time earnings are calculated net of any investment in education or on-the-job training. The individual's human capital production function can be regarded as his proficiency in combining his time, education, experience and other goods into outputs of human capital.

These models have been successful in providing a rigorous theoretical foundation for many stylized facts such as a wage path which rises sharply at the start of the working life, continues to grow at a slower rate with a weak tendency for wage reduction towards the end of working life. These theoretical models are also capable of explaining the interaction between earnings growth and individual characteristics such as sex and the level of schooling. However, these optimal human capital models are very abstract and thus hard to adopt in empirical work since the precise functional form for the earnings equation cannot be derived from the theory. Besides, many of the variables in these models, such as human capital itself, the individual's production function and his investment in time and other goods, are either unobservable or rarely observed in the available data.

Mincer (1974) sought to integrate the theories of investment in education and on-the-job training, developed by Friedman and Kuznets (1945), Becker (1964) and Mincer (1962, 1974), with more formal models of life cycle earnings such as Ben-Porath (1967) to provide an empirical framework with firm theoretical foundations. The earnings function in Mincer (1974) has dominated the literature; it has been successfully applied in many studies and to data from numerous countries.

Mincer (1974) assumes that individuals are homogenous and that each one has a stock of human capital E_0 at the age of school entry, t=0, he spends S years in education and then starts working. While working, he continues to invest a proportion k(t) of his earnings capacity in on-the-job training but this investment declines to zero towards the end of his working life so that after X years of experience his investment can be measured approximately by:

$$k(X) = k(0)-[k(0)/N]X \qquad (5.2.1)$$

where N is the length of the working life, or, more precisely, the length of time for which investment takes place.

If the rate of return to the individual is assumed to be a constant rate of ρ for each additional year of schooling and g for each year of on-the-job training then his human capital earnings capacity can be regarded as:

$$E(X,S) = E_0 \exp\{\int \rho k(t)dt + \int gk(t)dt\} \qquad (5.2.2)$$

where the first integral is between 0 and S and the second from S to X.

Actual earnings net of investment costs are:

$$Y(X,S) = (1-k(X))E(X,S) \tag{5.2.3}$$

We substitute $k(t)=1$ for $0<t<S$ and $k(t)=k(0)-[k(0)/N]t$ for $S < t < X$ into (5.2.2) and the resulting earnings capacity into (5.2.3). Taking logs provides:

$$\ln Y = \ln E_0 + \rho S + gk(0)X - (gk(0)/2N)X^2 + \ln(1-k(X)) \tag{5.2.4}$$

This is equivalent to equation 5.2b (page 90) in Mincer (1974). He then estimated (5.2.5) as an approximation to (5.2.4):

$$\ln(Y) = a + bS + cX + dX^2 + u \tag{5.2.5}$$

where u is a random error term, $a=\ln E_0-k(0)[1+k(0)/2]$, $b=\rho$, $c=gk(0)+k(0)[1+k(0)]/N$ and $d=-[gk(0)/2N + k^2(0)/2N^2]$.

Mincer also postulated a non-linear exponential version of (5.2.1) to derive a similar earnings function. This captures the fact that investment in on-the-job training is very high for the first few years of the working life and then declines rapidly thereafter. We will pursue this notion further in our econometric formulation.

Mincer's celebrated estimate of (5.2.5) from the US Census of 1960 is given below in Table 5.2.1. Here, X is simply [age - (S+6)] since the Census only contained information on the number of years in education and the individuals' age and no information on actual experience. 6 is the age at which schooling commences in the US. In Table 5.2.1 Y is annual earnings.

Table 5.2.1

Mincer's earnings function	
$\ln Y = 6.20 + 0.107S + 0.081X - 0.0012X^2$	
(72.3) (75.5) (55.8)	(t-stats)

The estimated rate of return to schooling is 10.7 per cent and the coefficients of experience and its square indicate that earnings growth is 8.1 per cent at the beginning of working life, decreasing continuously to reach zero after 34 years of experience and becoming negative thereafter. The regression explained 28.5 per cent of the variation in log earnings.

In order to capture the possibility that the rate of return to education may not be linear as suggested by (5.2.4) Mincer included S^2 in the earnings function of Table 5.2.1 and found that this was negative and significant, indicating a decreasing marginal return to education. He also included an interaction between schooling and experience, SX, which was found to be negative and significant denoting that the earnings differential by schooling diminishes as individuals acquire more experience. However, when he introduced a variable to represent the number of weeks worked during the year by each individual, W, both S^2 and SX became insignificant. Furthermore, the coefficient on W was not significantly different from one. We shall return to this variable below.

Mincer's earnings function became the focus of theoretical and econometric scrutiny due to its success in repeated studies with data from countries with completely different economic and technological structures. Griliches (1977) and Rosen (1976) provide a comprehensive set of econometric and theoretical assumptions made in application of (5.2.5) some of which were readily acknowledged in Mincer (1974).

In (5.2.4) if k(t), E(0) or ρ are individual specific then the parameters a, b, c or d of (5.2.5) will be individual specific. For instance, if ρ is individual specific then the residual term, u, will be an increasing function of schooling and will no longer be homoscedastic. Besides, the residuals will also be correlated with the schooling term causing upward bias in the estimate of return to schooling.

A very curious problem arises if we assume that individuals face the same market interest rate: Mincer's model suggests that there will be no demand for education if the individual's rate of return is less than the market rate of interest. If ρ is greater than the rate of interest then the individual will demand education up to the point where his marginal discount rate is equal to the rate of interest. The higher his discount rate the more education he will demand. However, this is counterfactual to empirical findings.

Rosen (1976) points out the self-selection problem of Mincer's earnings function. If those who pursue more education are the more able then, as no allowance is made for ability, the marginal rate of return to education is over-estimated from (5.2.5). The earnings function will thus be influenced by the distribution of ability in the data sample. In fact, if one is to assume the equality of ability then everyone would choose the same level of schooling and the data will be void of any variation to be explained.

To save the earnings function (5.2.5) one would have to assume that ability is randomly distributed within the sample. Alternatively, one could assume that there is equality of ability but inequality of opportunity, i.e., individuals face different interest rates. There have been a number of US studies exploring the magnitude of the ability bias, e.g. Griliches (1979) and Willis and Rosen (1979). However, in his survey, Willis (1986, page 589), concludes that because of the complexity of the econometric and theoretical issues involved in modelling ability bias and the limited and unrepresentative data available to explore the issue, "it is difficult to reach any conclusions about the magnitude or even the direction of the bias".

Mincer finds his best empirical formulation when he controls for weeks worked, W. However, W cannot possibly be regarded as exogenous. A complete model of individual choice has to incorporate labour supply decisions explicitly. This is particularly important when considering returns to human capital investment for women because of their commitment to non-market activities. The emphasis on labour supply should not distract us from considering the demand side. The theoretical framework presented so far focuses on the individual's decision but overlooks the demand for human capital by the firms.

Willis (1986) argues that Mincer's theoretical framework can be given a more concrete foundation by relaxing the assumption that all individuals are perfect substitutes, i.e., the assumption of homogeneous individuals. Here, we adopt a slightly modified version of Willis's model to form the theoretical basis of our empirical study.

Suppose that there are many types of human capital, each uniquely suitable for a particular "task". A task can be considered as an occupation or even as an occupation in a given industry. Let us for simplicity denote each task as an occupation. We assume that each occupation requires a rigid educational qualification in terms of the number of years of education and that workers are imperfect substitutes across occupational categories. Let there be m distinct tasks each requiring S_j years of education where $1<=j<=m$ and S_1 is the minimum school leaving age. Without loss of generality and to make our analysis somewhat simpler, we assume, for the moment, that there is no on-the-job training.

Individuals vary in their ability. This is exhibited by their efficiency in their chosen occupation. Let

$$l_i = (l_{i1}, \ldots, l_{im}) \qquad (5.2.6)$$

be the ability endowment of the ith worker indicating that his efficiency in occupation j is l_{ij}. If the individual is paid w_j per efficiency unit in occupation j then his earnings will be $w_j l_{ij}$ and his potential earnings in each occupation is given by the following vector:

$$\begin{aligned} Y_i &= (Y_{i1}, \ldots, Y_{im}) \\ &= (w_1 l_{i1}, \ldots, w_m l_{im}) \qquad (5.2.7) \end{aligned}$$

Person i will choose the occupation j which maximises the net present value of his life-time earnings:

$$V_{ij} = \int Y_{ij} \exp(-\rho_i t)\, dt = (\alpha_i Y_{ij}/\rho_i) \exp(-\rho_i S_{ij}) \qquad (5.2.8)$$

where $\alpha_{ij}=1-\exp(-\rho_i N)$, N is the number of years of education and the integral is from s_j to s_j+N+6.

Willis (1986) makes two simplifying fundamental assumptions in order to derive the earnings function. The first is that of "equality of opportunity". According to this assumption, there is free access to education and individuals face a common interest rate r. The second assumption is what he calls the "equality of comparative advantage". This is a weaker condition than assuming that all individuals have identical abilities. He simply assumes that individual ability endowments are identical up to a constant factor:

$$l_i = \bar{l}\exp(A_i) = (\bar{l}_1, \ldots, \bar{l}_m)\exp(A_i) \tag{5.2.9}$$

where A_i is an individual specific constant factor and A_i is scaled such that $E(A_i)=0$ and the bar indicates that l is the ability vector of the average person.

To overcome the problem of covariance between ability and schooling, Willis takes a leaf out of Rosen (1976) and appeals to the theory of equalizing differences. He makes the assumption that any given individual is randomly assigned to his schooling/occupation category. This can be achieved if the net present value of the earnings stream from the m occupational choices are equalised. Willis shows that this condition is satisfied if

$$Y_{ij}/Y_{i1} = \exp(\rho S_{ij}) \tag{5.2.10}$$

or equivalently if

$$w_{ij} = w_1(\bar{l}_1/\bar{l}_j)\exp(\rho S_{ij}). \tag{5.2.10'}$$

Now consider the demand side of the market: let F be the aggregate production function to produce a composite good:

$$F = F(L_1, \ldots, L_m; K, T) \tag{5.2.11}$$

where L_j, $1 \leqslant j \leqslant m$, is the aggregate demand for efficiency units of labour of jth occupational category, K is the aggregate capital stock and T captures technical progress.

Labour market equilibrium is determined by the interaction of the aggregate supply and demand for workers in each occupation. Let w^* be the equilibrium value of w, then:

$$w_j^* \geqslant F_j \qquad (5.2.12)$$

where F_j is the marginal product per efficiency units.

Therefore equilibrium earnings will be:

$$Y_{ij}^* = w_{ij}^* \bar{l}_{ij}$$

$$= [w_1^* (\bar{l}_1/\bar{l}_j) \exp(\rho S_i j)] \bar{l}_j \exp(Ai) \quad \text{(substituting 5.2.10')}$$

$$= w_1^* \bar{l}_1 \exp(\rho S_i j + Ai) \qquad (5.2.13)$$

Taking the log of both sides of (5.2.13)

$$\ln(Y_i j) = a + \rho Sj + Ai \qquad (5.2.14)$$

where $a = \ln(w_1^* \bar{l}_1)$.

We can similarly introduce on-the-job training to obtain

$$\ln(Y_{ij}) = a + \rho S_{ij} + cX_{ij} + dX^2_{ij} + A_i \qquad (5.2.15)$$

where $X_i j$ is the level of experience of individual i in occupation j.

We note the resemblance between (5.2.15) and Mincer's (5.2.5), the only difference is that the latter controls for occupational groupings and is a particular case of a more general human capital theory. In particular, the assumption of random choice among occupational alternatives insures that A_i is homoscedastic and that there is zero covariance between A_i and S_{ij}. If this assumption is true, then a regression of log earnings on schooling and years of experience will provide us with consistent estimates of return to schooling and to investment in on-the-job training if we control for occupational categories.

Willis (1986) demonstrates that it is also possible to derive (5.2.15) under a somewhat weaker set of conditions. For instance, he relaxes the assumption of a rigid schooling qualification for each occupational grouping and the assumption of equal comparative advantage and shows that the above earnings function can be derived if the production function for each individual i in occupation j is of the form $l_{ij}=A_i\ H_j(S_{ij})$. He also illustrates that it is possible to derive (5.2.15) without assuming that wage differentials are perfectly equalized, instead it will suffice to assume that some workers move occupations to maintain the structure of the schooling occupational wage differential.

For (5.2.15) to be valid in the long-run, one must also assume that there is little movement among occupational categories. Alternatively, one can use broad occupational definitions in attempting to estimate (5.2.15), so that although individuals may change jobs, they would stay within the same occupational grouping.

In short, Mincer's earnings function and Willis's re-interpretation of it point to the importance of controlling for educational attainment, experience and occupation as the basis of any empirical investigation of individual earnings.

5.3. Description of the data

The data for our study are obtained from the Family Expenditure Survey, FES. Currently, data from sixteen annual surveys are available for academic analysis, covering the period 1970 to 1985 inclusive. Unfortunately, human capital variables, which as we shall see are immensely important in explaining individual earnings, are only available from 1978 onwards. Therefore, we concentrate our efforts on estimating a time series of cross-section wage equations for the period 1978 to 1985 inclusive.

The FES provides annual data on over 18,000 individuals, including children, from about 7,000 households. The sample size is approximately 10,000 households, meaning a response rate of some 70 per cent. The respondents are interviewed in depth to provide three categories of data. The first category is household data such as household composition, the number of dependent children in the household, type of accommodation, possession of various household goods, etc. The second category is data on each individual in the household including personal attributes such as age, sex, marital status, age at which full-time education ceased (1978 onwards), occupation, as well as detailed information on income such as net income, deductions from gross earnings, income from subsidiary employment, benefits, investment income, etc. The third category of data provides precise information on items of expenditure by either individual members of the household such as expenditure on clothing, or by the entire household collectively such as expenditure on fuel.

We are primarily interested in the first two categories of data since they depict a reliable picture of the individual's income, personal attributes and household features as well as providing some information on the individual's employment.

We mentioned above that 30 per cent of the households sampled for the FES do not respond to the survey; Redpath (1986) argues that the non-response rate in the FES is not random and could cause bias in estimation. Gomulka and Stern (1986) argue that although this non-response to the FES is a drawback, it is partly a consequence of the high standard of record-keeping required for those who participate in the survey. Besides, other annual surveys such as GHS also suffer from this drawback as well as from the disadvantage of inconsistency across the years mentioned above.

We intend to employ the human capital theoretical model set out in section 5.2 as the basis for our empirical investigation; the dependent variable in this case has to be a market value measure of wages. For this purpose we limit our sample to those who are employees, rather than self-employed, and thus their income is a good measure of what they command in the market place for their human capital. Also we know from a large body of literature, e.g. Greenhalgh (1977), Layard, Barton and Zabalza (1980), Joshi and Owen (1981), that the determinants of women's pay are very different to those of men. Since Gomulka and Stern (1986), using FES, provide wage equations for women, albeit for a different sample period and using a different framework for analysis, here we concentrate on estimating wage equations for men.

Due to these restrictions, our sample consists of male employees in employment aged 16-64, leaving us an annual sample of about 3500 individuals.

Table A5.1, in the appendix, presents the list of all variables which we include in our model except the industrial ones; the industrial categories are presented in Table A5.2 and Table A5.3 provides the means and standard deviations of all the variables.

Between 1978 and 1985 real gross earnings, (in 1985 prices), rose from an average of £147 to £182 in our sample. Real gross wages increased from an average of £3.32 to £4.28 per hour, an increase of 28 per cent in real terms. These increases are very much in line with those from the New Earnings Survey in Table 5.3.1. All these figures have large standard deviations signifying the broad dispersion of earnings and wages across occupations, industries, regions and among people with different human capital attributes.

Table 5.3.1

Changes in wages and earnings between 78 and 85

Real earnings		Real wages	
NES	FES	NES	FES
24%	26%	29%	31%

The FES data provide the age of the individuals as well as the age at which the individual left full-time education; we approximate the individual's labour market experience, X, as the difference between the two.

The age at which full-time education ceases shows a distinct pattern between 1978 and 1985. The proportion of individuals remaining in full-time education for longer periods has risen remarkably. This is no doubt partly a consequence of raising the minimum legal age for school leavers, but that in itself cannot explain the fact that the proportion of the working population staying in full-time education until they are 21 years or more has risen from under 4 per cent in 1978 to over 9 per cent in 1985, rising particularly sharply from 1982. Raising the minimum school leaving age can explain the fact that the proportion of those in our sample who left full-time education at the ages of 14 and 15 fell from 25 per cent and 34 per cent respectively in 1978 to 11 per cent and 27 per cent in 1985. Against this, the proportion of the labour force who had left full-time education at the age of 16 rose from 21 per cent in 1978 to 31 per cent in 1985. There has also been a tendency for the proportion of those staying in full-time education until they are 17 or 18 to rise sharply during the first half of 1980's. The same applies to those who left full-time education when they were 19 or 20, although they form a very small group of individuals.

The regional distribution of our annual samples does show some fluctuation but this is small enough to be attributed to the sampling error. One can also detect signs of regional migration from the annual samples: the proportion of individuals in the South East grows from about 17 per cent in 1978 to some 20 per cent in 1985 while the proportion of individuals in the North, the North West and Scotland declines by approximately one percentage point each.

The proportion of those in each broad occupational category shows an interesting pattern. Between 1978 and 1985 the fraction of unskilled men falls from about 6 to 4 per cent, the proportion of those in semi-skilled occupations in the sample falls from 24 to 16 per cent and the ratio of those in skilled manual occupations falls from 50 to

38 per cent. The data also show a rising trend in the proportion of professional as well as administrative workers, with a very sharp rise in 1982. This is no doubt partly a consequence of the fall in the ratio of skilled and semi-skilled workers and partly reflects the intrinsic growth of these occupational categories.

One must bear in mind that in 1981 the British economy experienced a very severe recession. The data show that this downturn in economic activity had a very asymmetric impact on our broad occupational categories. The recession took its toll primarily on skilled, semi-skilled and unskilled manual workers. The stability of the proportion of male employees in each category after 1981 suggests that either the recession induced a restructuring process in the economy or else there was a very slow recovery from the recession.

FES provides data on the industry in which individuals work; there are 32 industrial categories for the period 1982-1985 and 28 categories for the period 1978-1981. Unfortunately, the SIC industrial classification, on which the FES categories are based, changed in 1982. Consequently, the individual categories for 1982-85 cannot be readily compared to those for the earlier years. However, 14 categories remained unchanged so their impact on wages can be directly traced. Given that the categories are exhaustive and mutually exclusive, we can control for the industry of each individual although we cannot directly trace the coefficient of each industrial category across the years in our sample.

The industrial categories are presented in Table A5.2; this table also indicates whether a category can be compared across the years. The analysis of the means of the industrial dummies in Table A5.3 is best undertaken by comparing the first four columns together and then considering the next four. There is considerable fluctuation in the means and the break in 1981/82 makes it difficult to ascertain any trends, nonetheless, it is possible to identify a few industries such as metal extraction and manufacture, IND4, and manufacture of vehicles, IND9, in which the proportion of male employees in our sample declined between 1978 and 1985; similarly the period between 1978 and 1985 saw a rise in the proportion of individuals in distributive trades, (wholesale and retail), IND19, and insurance, banking, finance, etc, IND25.

The proportion of married individuals in the sample remains fairly stable throughout the sample period, however, the proportion of those with any children shows a distinct decline. Gomulka and Stern (1986) explore in detail the changing family structure for married women.

There are two questions in the FES which give an indication of whether or not the individual is a member of a professional body or a trade union. The first question provides information on payments by bankers standing order to trade unions or professional organisations and the second indicates if any such payments are deducted from pay. Hence, we can construct eight dummies for the FES occupational categories to control for membership of professional organisations or trade unions. However, these variables have to be treated with caution. They do not provide a proper control for membership of unions or other professional bodies since we do not have full information on membership through the above two questions. Furthermore, the second question, which is the prime source of information, was only included in the FES from 1982. Therefore, estimates prior to 1982 would be based on very small samples and thus questionable.

Table A5.3 also provides the means of these occupational 'membership' variables, DP1-DP8. Between 1983 and 1985 when better data are available, about 41 per cent of individuals are members of professional organisations through paying their subscriptions by standing orders or direct deduction of pay. The proportions are highest among skilled manual workers followed by semi-skilled manual workers and professionals. The lowest 'membership' rate is among shop assistants. These figures are very stable between 1982 and 1985. However, prior to 1982, when the only source of information on membership is payments through standing orders, the figures become very erratic and unreliable falling to less than one per cent for every occupational category. Standing orders are simply not a popular way of paying membership dues!

5.4 Towards an empirical framework

Our econometric model is based upon the theoretical model of Willis (1986) outlined in Section 5.2. This is essentially a more coherent theoretical re-interpretation of Mincer's pioneering human capital model. We make a number of modifications to Willis's representation of Mincer's earnings function derived in (5.2.15):

$$\ln(Y_{ij}) = a_o + \rho\ ED_{ij} + c\ X_{ij} + d\ X^2_{ij} \tag{5.4.1}$$

where Y is income, ED years of education and X years of labour market experience of the individual i in the occupation j.

Specifying years of schooling, S, simply as a linear function neglects the likelihood of a non-constant rate of return to education. For instance, the marginal rate of return to higher education may be decreasing, a prospect potentially detrimental to this author! To allow for the non-linearity in returns to education, some authors, e.g. Krueger and Summers (1988) or Arellano and Meghir (1989), have used a quadratic of the school leaving age. However, this approach simply replaces the assumption of constant marginal returns to education with the assumption that returns to education are a linear function of schooling. Exactly the same critique applies to including experience and experience squared as in the above formulation. In our econometric model, we adopt a more flexible approach.

For years of education we simply include a series of dummies for each extra year the individual stays in full-time education beyond the minimum school leaving age. This approach not only allows us to ascertain the exact return to one extra year of education but also enables us to test whether it is the absolute level of education which matters or the relative level compared to the minimum leaving age. The latter is an important policy issue and to our knowledge has never before been tested in the literature on returns to schooling. Given that the individuals in our sample have faced two changes in the minimum school leaving age - once in 1947, when it rose from 14 to 15, and again in 1972, when it increased to 16 - we have the opportunity of investigating this issue.

Instead of the conventional quadratic labour market experience, which is symmetrical about its peak, we take a leaf out of Stewart (1983) and specify a linear spline, X1 to X6, to capture the returns to the labour market experience profile. X1 and X2 are each five years in length and represent the first and the second five years of experience in the labour market. X3 to X6 are each 10 years in length, portraying the subsequent decades of experience; e.g.

$$X3 = \begin{cases} 0 & \text{if } X<20 \\ X-10 & \text{if } 20<=X<30 \\ 10 & \text{if } X>=30 \end{cases} \qquad (5.4.2)$$

We also include six interaction terms between Xi's and an educational dummy for those staying in full-time education beyond the age of 18. This is to allow for a different experience profile for those entering higher education.

The set of variables representing experience and educational attainment plus a group of occupational dummies provide a generalised version of the human capital earnings model (5.4.1) which forms the basis of our empirical investigation.

To this basic model we add two variables representing family circumstances: the individual's marital status and a binary variable indicating whether the individual has any dependent children. We avoid complicating the estimation by including variables such as the economic status of the spouse or the type of tenancy which are available from the FES but are not exogenous.

We include regional dummies for the eleven standard regions in Great Britain to capture regional differences in pay. Data are available for Northern Ireland but we excluded the individuals in this region due to the special circumstances of this area.

In a standard text book competitive framework with perfect mobility of labour, differences in wages across industries can arise because of compensating differentials. If, for example, accident rates or lay offs are more common in one industry or conditions of work are undesirable, then workers are paid extra in compensation. In an imperfectly competitive economic framework, inter-industry wage differentials can arise either because of product market power on the side of the industry or due to union ability to organise and extract higher wages. Krueger and Summers (1986) argue that another rationale for inter-industry wage differences is the existence of efficiency wages. If productivity and pay are positively related and, furthermore, their relationship varies across industries, then identical workers would receive different wages depending on their industrial affiliation.

To control for these inter-industry variations we incorporate the industry level binary variables listed in Table A5.2 in our wages equation. In addition, we have a crude measure of membership for the last three years of our sample as explained in Section 5.3; however, FES does not provide any information on the nature of the individual's job beyond the broad occupational categories. Nor does it provide any information on the employer. However, this weakness is a feature of all other individual level annual surveys available in the public domain.

In accordance with (5.4.1) our dependent variable is the log of real gross wages. (5.4.3) which is based upon (5.4.1) represents the econometric model that we have estimated:

$$\ln(Y) = a_0 + \sum_{1}^{n} \rho_i \, ED_i + \sum_{1}^{6} c_i \, X_i + \sum_{1}^{6} d_i \, UX_i + \sum_{i \neq 5}^{11} g_i \, REG_i + \sum_{i \neq 7}^{8} h_i \, OCCi$$

$$+ \sum_{1}^{8} k_i \, DPi + \sum_{2}^{32} l_i \, IND_i + a \, MAR + b \, DEP + u \quad (5.4.3)$$

where EDi's are the educational dummies; Xi's the experience splines; UXi's are the interaction dummies between Xi's and those staying in full-time education beyond the age of 18; MAR indicates if the individual is married; DEP is a binary variable representing the presence of young dependents; REGi's are regional dummies; OCCi's are occupational dummies; DPi's indicate membership of professional bodies; INDi's are industry dummies and finally u is the error term.

We also need a methodology to compare our results across the years. Oaxaca (1973) provides a suggestion as to how this could be done. In assessing male-female wage differentials, he estimates male and female wage equations; from the properties of ordinary least squares estimation we have:

$$\overline{\ln(W_m)} = \bar{Z}'_m \hat{\beta}_m \quad (5.4.4)$$

$$\overline{\ln(W_f)} = \bar{Z}'_f \hat{\beta}_f \quad (5.4.5)$$

where m and f represent male and female and bar indicates sample mean and hats signify OLS estimator; W is the wage and Z the vectors of regressors and finally, β's are the vectors of coefficients.

The male-female wage differential will then be:

$$\Delta\overline{\ln W} = \bar{Z}'_m \hat{\beta}_m - \bar{Z}'_f \hat{\beta}_f \tag{5.4.6}$$

where Δ indicates male/female difference. (5.4.6) can be re-written as

$$\Delta\overline{\ln W} = \Delta\bar{Z}' \hat{\beta}_f + \bar{Z}'_m \Delta\hat{\beta} \tag{5.4.7}$$

Oaxaca (1973) argues that the first term can be regarded as the estimated effect of differences in individual male-female characteristics and the second term as the estimated effect of discrimination. We can apply the same methodology in our study. Instead of both a male and female equation we have wage equations for different years; we can decompose the difference in estimated average hourly earnings into changes in the coefficients and changes in the average value of the explanatory variables. This is also the approach adopted by Gomulka and Stern (1986) in decomposing the increase in participation of women into changes of estimated coefficients and changes of sample characteristics.

In our case we know from the properties of the OLS that

$$\bar{y}_t = \bar{X}'_t \hat{\beta}_t \tag{5.4.8}$$

where t indicates the cross-section year; y is the log of individual real wages, X is the vector of regressors and β is the vector of estimated coefficients; bars indicate sample means and a hat indicates an estimator.

Let Δ indicate difference across any two years, i.e. $\Delta y = y_t - y_{t-1}$. We can apply Oaxaca's methodology to obtain:

$$\Delta\bar{y} = \bar{X}' \Delta\hat{\beta} + \Delta\bar{X}' \hat{\beta} \qquad (5.4.9)$$

Accordingly the change in the mean of real wages can be decomposed into two terms. The first term on the right hand side can be thought of as the change due to shifts in coefficients assuming constant values of the regressors. Any shifts in the coefficients represent changes in the market valuation of the individuals' attributes. The second term in (5.4.9) can be regarded as the change in the characteristics of the individuals assuming constant coefficients.

In our empirical work we will estimate the econometric model (5.4.3) and then decompose the change in real wages from year to year according to (5.4.9) in order to ascertain the causes of real wage growth.

5.5 Empirical results

Before proceeding to examine the results in detail, we wish to explore whether it is the absolute level of education or the relative level of education in comparison to the minimum school leaving age that matters when it comes to wage determination.

This exercise is possible because the minimum school leaving age has changed three times this century. In 1918 it was raised to 14 years; therefore nobody in our sample could have left school legally before they were 14. There are some men in our sample who did leave school before the minimum school leaving age either on account of the fact that they emigrated to Great Britain after the end of their education or because they left illegally. We group these individuals in a separate category, EOED.

On 1 April 1947 the minimum school leaving age was raised to 15 as a result of the 1944 Education Act. The minimum school leaving age was raised once more in 1972 to the current age of 16. There is a slight complication: if an individual's birthday is between 1 September and 31 January, he or she can leave school at the end of the Easter term following their sixteenth birthday. However, if the individual was born between 1 February and 31 August, he or she can leave on the last Monday in May. Therefore if someone's birthday falls between the last Monday in May and the end of August they would be fifteen when they left school. We have no way of detecting this category as all we know is the age at which individuals leave full time education. We have grouped anyone leaving school before the strict minimum leaving age in category EOED, this is about 4 to 5 per cent of the sample.

As individuals in our sample were subject to three different minimum school leaving ages we are able to investigate whether the absolute number of years of schooling that influences earnings or the relative number of years in comparison to the prevailing minimum school leaving age.

We have formulated an education dummy group for each of the three minimum school leaving age categories. The first group is a series of dummies indicating the age of leaving full time education when the minimum leaving age was 14. The second and third groups provide similar dummies for when the minimum leaving age was 15 and 16 respectively. The definitions for the dummies are given in Table 5.5.1 below:

Table 5.5.1

Definition of education dummies

E0ED	Those leaving before the minimum school leaving age
E1ED14	Those leaving at the minimum age of 14
E1ED15	Those leaving at 15 when the minimum age was 14
E1ED16	Those leaving at 16 when the minimum age was 14
E1ED1718	Those leaving at 17 or 18 when the minimum age was 14
E1ED1920	Those leaving at 19 or 20 when the minimum age was 14
E1ED21	Those leaving at 21+ when the minimum age was 14
E2ED15	Those leaving at 15 when the minimum age was 15
E2ED16	Those leaving at 16 when the minimum age was 15
E2ED1718	Those leaving at 17 or 18 when the minimum age was 15
E2ED1920	Those leaving at 19 or 20 when the minimum age was 15
E2ED21	Those leaving at 21+ when the minimum age was 15
E3ED16	Those leaving at 16 when the minimum age was 16
E3ED1718	Those leaving at 17 or 18 when the minimum age was 16
E3ED1920	Those leaving at 19 or 20 when the minimum age was 16
E3ED21	Those leaving at 21+ when the minimum age was 16

To test the null hypothesis that it is the absolute level of schooling which matters, we estimated (5.4.3) using the above set of dummies (E2ED15 as the base) for ED_is. We then carried out an F-test on each group of dummies in turn to establish whether the dummies representing a particular level of education had the same coefficient. The coefficients for 1985 are given in Table 5.5.2 and the corresponding F-tests for the years 1983, 1984 and 1985 are given in Table 5.5.3. Prior to 1982 some of the educational categories become too small to carry out these tests satisfactorily. However, Table 5.5.3 also reports the results of the same tests for 1979. These latter results for 1979 are only given to ensure that the findings are robust across the years, but they should be treated with caution due to the small sample size in some categories.

Table 5.5.2: Education dummies for 1985

Variable	Estimate	SE
E0ED	-0.0005	(0.0340)
E1ED14	0.0114	(0.0474)
E1ED15	0.0611	(0.0579)
E1ED16	0.1689	(0.0545)
E1ED1718	0.3607	(0.0675)
E1ED1920	0.3062	(0.2297)
E1ED21	0.604	(0.1791)
E2ED15	(base group)	
E2ED16	0.1156	(0.0207)
E2ED1718	0.209	(0.0269)
E2ED1920	0.5278	(0.1390)
E2ED21	0.6779	(0.1295)
E3ED16	0.0826	(0.0374)
E3ED1718	0.1862	(0.0461)
E3ED1920	0.4841	(0.1088)
E3ED21	0.5536	(0.0987)

Adj R-sq	0.5289	SEE	0.1184
Sample size	3626		

The dependent variable in the equation presented in table 5.5.2 is y, the log of the individual's real average earnings. The equation also included all the other variables from (5.4.3), we shall discuss these variables when we present the full set of results.

The base group for the above educational dummies in Table 5.5.2 is E2ED15, those leaving full-time education at the minimum age of 15. All the educational dummies apart from E0ED, those leaving before the minimum age, E1ED14 and E1ED15, those leaving at 14 and 15 respectively when they could have left at 14, are significant in determining log wages.

Now to the main objective of this exercise. At a quick glance, the coefficients of a given level of education in different minimum age regimes are roughly equal. The formal F-test for this is given in Table 5.5.3 below:

Table 5.5.3

F-tests for the equality of educational dummies

The null	F-statistics			
	1985	1984	1983	1979
E1ED16=E2ED16=E3ED16	1.00	3.23	1.71	1.85
E1ED1718=E2ED1718=E3ED1718	2.68	1.45	0.43	2.24
E1ED1920=E2ED1920=E3ED1920	0.71	0.64	0.86	0.70
E1ED21=E2ED21=E3ED21	1.13	3.46	0.42	0.18

Critical $F(2,\infty)_{0.01}=4.61$

Critical $F(2,\infty)_{0.05}=3.00$

The null hypothesis that the coefficients are equal cannot be rejected at the one per cent level for any of the educational categories across the years. At the five per cent level the null is marginally rejected only for those leaving full-time education at 16 and 21+ in 1984. Given that the hypotheses can neither be rejected at the one per cent level nor at the five per cent in all the years apart from 1984, we conclude that it is the absolute level of education rather than the relative level, in comparison with the minimum school leaving age, that matters when it comes to wage determination. We thus impose this restriction in our cross-section wages equations.

Let us now turn to the main body of our results. The time series of cross-sections are presented in Table A5.4, in the appendix. The overwhelming majority of the variables are highly significant and the F-test for the joint significance of each equation is very significant. The cross-section equations typically explain 50 per cent of the variation in the log of average hourly earnings and the standard errors of the equations are low. Thus, the explanatory power of our cross-section equations is rather high for individual level data. The White's standard errors were carefully inspected to insure homoscedasticity.

The correct way to test for significance is to carry out an F-test for the joint significance of a group of variables in each cross-section wage equation. Table 5.5.4 presents the results of F-tests for the joint significance of each group of variables in any given year. The F-tests indicate that the experience splines, regional dummies, occupational dummies, industry dummies and 'membership' dummies are all jointly significant for every equation. The set of dummies which tests for the significance of any interaction between higher education and experience is only significant in five out of the eight years.

Table 5.5.4

F-tests for the joint significance of a group of variables

	1978	1979	1980	1981	1982	1983	1984	1985	Critical -F
X	106.0	100.0	93.0	106.0	118.0	90.1	89.5	84.1	2.1
UX	5.9	1.9	1.2	6.4	3.4	5.5	1.3	3.8	2.1
REG	6.9	5.0	8.6	4.1	5.2	11.8	10.6	7.8	1.9
OCC	19.9	18.9	20.7	20.6	47.9	37.2	45.0	36.0	1.7
DP	3.4	2.0	2.1	2.3	5.1	8.2	6.7	5.0	1.9
IND	13.5	16.7	10.6	19.6	21.3	13.2	13.6	11.6	1.5

Turning to the individual coefficients, there are a number of interesting findings. The experience profiles, X1 to X6, exhibit a similar pattern to that found by Stewart (1983): they rise very steeply for the first five years and then flatten for the next 25 years of an individual's working life before declining for the last ten to twenty years. The set of interaction dummies, UX1 to UX6, indicates that for those who continue full-time education beyond the age of 19, the experience profile rises less steeply in the first five years, continues to rise for the next fifteen years or more before declining towards the end of working life.

We have already discussed the full set of educational dummies above.

In the time series of cross-sections, presented in Table A5.4 of the appendix, we have simply included a set of binary variables representing the age on completion of full-time education irrespective of the minimum school leaving age; the base group is those leaving full-time education at 15. These coefficients represent the returns to different levels of education.

In all the estimated years, the earnings of those who left school before the legal minimum age or at fourteen are not significantly different from the base year. Although there are some fluctuations in the estimated coefficients of the education dummies, there does seem to be a clear pattern. The coefficients for all the educational dummies show an increase between 1978 and 1985.

Table 5.5.5

Relative educational wage differentials, exp(EDi)-1

	1978	1979	1980	1981	1982	1983	1984	1985
ED16	0.009	0.080	0.081	0.069	0.068	0.079	0.119	0.120
ED1718	0.103	0.136	0.084	0.137	0.106	0.162	0.164	0.249
ED1920	0.101	0.211	0.273	0.160	0.221	0.560	0.407	0.564
ED21	0.282	0.277	0.387	0.224	0.462	0.923	0.650	0.813

We must bear in mind that the estimated wage equations are semi-log linear, therefore the wage differential between the base group and any one dummy is simply the exponential of the estimated coefficient minus one. Table 5.5.5 gives the wage differentials for each level of education compared to those leaving school at the age of fifteen. These are the returns to a given level of education compared to leaving full-time education at fifteen. Our main empirical results in Table A5.4 demonstrate that it is hazardous to make inferences from any one year in isolation, however, both Table A5.4 and Table 5.5.5 illustrate that the returns to an extra year of education rose considerably between 1978 and 1985. Later in this section, we will investigate whether wage inflation has risen due to increased returns to education.

Table 5.5.6

Regional wage differentials, exp(OCCi)-1

	1978	1979	1980	1981	1982	1983	1984	1985
REG1	-0.102	-0.059	-0.115	-0.072	-0.073	-0.137	-0.161	-0.144
REG2	-0.103	-0.109	-0.129	-0.063	-0.084	-0.160	-0.139	-0.117
REG3	-0.143	-0.062	-0.134	-0.104	-0.069	-0.137	-0.142	-0.140
REG4	-0.149	-0.082	-0.156	-0.102	-0.093	-0.120	-0.143	-0.135
REG6	-0.078	-0.002	-0.045	-0.048	-0.037	-0.057	-0.066	-0.044
REG7	-0.161	-0.091	-0.178	-0.123	-0.092	-0.155	-0.144	-0.127
REG8	-0.120	-0.091	-0.092	-0.107	-0.097	-0.176	-0.186	-0.125
REG9	-0.095	-0.072	-0.106	-0.103	-0.115	-0.169	-0.155	-0.135
REG10	-0.098	-0.067	-0.111	-0.099	-0.089	-0.138	-0.133	-0.145
REG11	-0.096	-0.069	-0.126	-0.096	-0.093	-0.122	-0.111	-0.081

Turning to our regional dummies, we see that all regions consistently suffer from an adverse wage differential in comparison to the Greater London region. Table 5.5.6 presents regional wage differentials relative to the Greater London region. The wage differentials fluctuate greatly over the eight years of our sample but the relative position of each region is fairly stable: the South East always has the smallest wage differential with Greater London. Although this changes from over eight per cent to less than 1 per cent during our sample period, no specific trend is discernible. Similarly East Midlands, North West and Wales are consistently the regions with the most unfavourable wage differential when compared to Greater London. On the whole, over the eight years of our sample, we cannot detect consistent rising or falling wage differentials.

Table 5.5.7

Occupational wage differentials, exp(OCCi)-1

	1978	1979	1980	1981	1982	1983	1984	1985
OCC1	0.329	0.354	0.328	0.409	0.466	0.462	0.526	0.555
OCC2	0.293	0.299	0.354	0.229	0.393	0.466	0.511	0.464
OCC3	0.669	0.676	0.542	0.416	0.570	0.471	0.778	0.500
OCC4	0.101	0.091	0.116	0.119	0.129	0.224	0.204	0.118
OCC5	0.145	0.024	-0.100	-0.040	0.019	-0.057	0.004	-0.112
OCC6	0.064	0.074	0.076	0.077	0.083	0.131	0.105	0.092
OCC8	-0.037	-0.042	-0.042	-0.075	-0.087	-0.003	-0.005	-0.035

The occupational dummies together with the 'membership' dummies present an interesting picture. The occupational dummies are jointly very significant and the estimates are consistent across the years. We must bear in mind that the dependent variable in each cross-section is average <u>hourly</u> earnings. Occupations, such as teaching, which exhibit high wage differentials relative to the base group, may do so due to shorter 'working' hours. Gomulka and Stern (1986) also found that teachers showed unusually high wage differentials. Figures from the New Earnings Survey 1985 indicate that teachers have lower weekly earnings relative to other professionals, but higher hourly earnings due to shorter working hours. Occupations which entail long hours of work, such as junior doctors (included in OCC1), may show smaller differentials than they would have done if we had used earnings as the dependent variable. These dummies illustrate the hierarchy of pay differentials: in every year the highest paid occupations are professional and technical workers (OCC1) and administrative and managerial workers (OCC2) followed by the teachers (OCC3). Clericals (OCC4) and skilled manual workers (OCC6) also enjoy a wage differential in comparison to our base group of semi-skilled manual workers (OCC7). The average earnings of shop assistants (OCC5) are only significantly different from those of semi-skilled manual workers in 1978. The wage differential of unskilled workers in comparison to semi-skilled workers is always negative, but only significantly so in 1981 and 1982. The estimated wage differentials are presented in Table 5.5.7. These values show a distinct trend. The estimated differentials for OCC1 and OCC2 rise steadily from 1978 to 1985: OCC1 rises from 33 to 55 per cent; for OCC2 it rises from 29 to 46 per cent. Sadly for the academic world the estimated differential for teachers, OCC3, falls from 66 in 1978 to 47 per cent in 1981 before recovering a little to 50 per cent in 1985. Looking at the standard errors in Table A5.4 we see that not all these changes are significant, for instance the coefficient for 1985 is not significantly different from that in 1978. The wage differentials for clericals, OCC4, and skilled manual workers show a modest but insignificant rise over the sample period.

A word of caution is necessary before we discuss the coefficient of the 'membership' dummies. DP1 to DP6 merely indicate if the individual pays a subscription to a union or a professional body through standing orders or direct deductions from pay, they do not represent a full picture of union membership and should not be regarded as representing union/non-union wage differentials. Also, the very small sample for our 'membership' dummies, DP1 to DP8, prior to 1982 make any inferences from the first five years of our sample impossible. We concentrate our disscussion of these 'membership' dummies to the last three year of the sample.

The 'membership' dummies have stable sample means and are highly significant in the last three years of the sample period. Membership of professional bodies or trade unions enhances the pay differentials of the workers in occupational categories OCC1, OCC2, OCC6 and OCC7 by between 6 per cent and 13 per cent. However, estimated coefficients are not stable over time. The estimated coefficient for DP1 collapses from 0.13 in 1982 to a mere 0.026 in 1985. The estimates for DP2, DP6 and DP7 fluctuate between 7 and 12 per cent but are not significantly different across 1983, 1984 and 1985. This represents a wage differential of between 7 to 13 per cent, (exp(.6)-1 to exp(.12)-1), for those who are members of unions or professional organisations. In spite of the problems with the 'membership' dummies, these results are consistent with the findings of other studies. For instance, Stewart (1990) examines changes in union wage differentials between 1980 and 1984 using comparable establishment level data sets. He finds that the mean union wage differential in semi-skilled occupations rises from 7 to 8.5 per cent during this period, however, this change is not statistically significant.

We observed in Table 5.5.4 that the industry dummies are highly significant in every cross-section wage equation which we have estimated. Adding the industry variables to the equation containing all the other variables typically reduces the standard error of the equation by 5 to 10 per cent.

The change in the industrial classification system between 1981 and 1982 makes it rather difficult to judge any changes in the estimated parameters over the whole sample. To avoid confusion, we should consider the results for the first four years and the last four separately. We see from the full results presented in Tables A5.4 of the appendix that the wage differential in comparison with the base group, agriculture, is highest for fuel extraction and processing (IND2), gas, electricity and water (IND3), paper, printing and publishing (IND16), and police and fire services (IND27), during 1982-85 period. The same industries together with mining and quarrying (IND5), enjoyed the highest differentials during 1978-81 period.

The distributive trades (IND19), recreational and cultural services (IND32), during 1978 to 1981 and hotels and catering (IND20) and personal and domestic services (IND32) from 1982 to 1985 suffered from negative or zero wage differential. These latter two categories did not exist in the 1978 to 1981 industrial classification.

The striking feature of the industry coefficients is the sudden decline in the coefficients of many industries in 1980; this can no doubt be attributed to the severe recession which beset the British economy in 1980/81. This decline in the coefficients is particularly stark in the pro-cyclical manufacturing sector; the coefficients in chemicals (IND6), shipbuilding (IND9), textiles (IND12), clothing (IND14) and bricks, pottery etc (IND17) declined by between 30 per cent and 60 per cent. Interestingly a number of industries were immune from falling pay differentials: these were industries with traditionally high differentials such as coal and petroleum (IND2), printing and publishing (IND16) and police and fire services (IND27).

The sudden decline in 1980 as well as the change in the industrial classification between 1981 and 1982 cause erratic movements to the industry coefficients. It is difficult to ascertain consistent trends over the sample period; nonetheless, a number of industries, especially during the first four years of our sample, significantly increased their favourable wage differentials in comparison to our base group. These include gas, electricity and water (IND3), between 1978 and 1981, electrical and electronic engineering (IND8) throughout the sample period, instrument engineering (IND10) during the first part of the sample and insurance, banking and finance (IND25) throughout the period. Many other industries also show modest rises in the estimated coefficients though the increase is often not statistically significant when one carries out an F-test for the equality of coefficients during 1978 to 1981 and again from 1982 to 1985. Although the absolute value of the estimates may rise by as much as 0.11, as in bricks, pottery, glass etc (IND17), the standard errors are large enough for this rise not to be significant.

With regard to the industry dummies, it would be instructive to investigate whether their influence would diminish if industry-specific variables were introduced to the cross-section wage equations. The Census of Production provides a number of industry-specific variables for the manufacturing sector. These variables are available for 13 of our industrial categories, IND4 to

IND17 (categories 12 and 13 are combined). We selected five industry specific variables for the manufacturing sector. These include the five-digit concentration ratio by employment (CR), the proportion of non-operative employees (PNOP), the price-cost margin (PCM), import-export competitiveness (IEC) and the proportional change in employment for each industry (PCE). The exact definitions are provided at the end of Table A5.2. We first estimated (5.4.3) for the manufacturing sector, IND4 to IND17, and then included the five industry specific variables. The industrial variables on their own are jointly significant at both the one and five per cent level ($F_{12,\infty}$ = 2.6), but not as significant as the full sample estimates presented in Table 5.5.4. When the five industry specific variables are added, the joint significance of the industry dummies is reduced ($F_{7,\infty}$ = 2.08). The industry dummies are still significant at the five per cent level but not at the one per cent level. This result has to be treated with caution since we only have industry specific variables for 13 categories. Besides, the industry specific variables and the dummies are linearly dependent, hence we have to drop an industry dummy for each industry specific variable which is added to the equation. Furthermore, some of the industry specific variables and the real wage are probably interdependent and have to be jointly modelled and estimated.

Our investigation into the estimated parameters of the cross-section wage equations illustrates that there have been significant changes in the educational and occupational coefficients. The industry coefficients also exhibit changes across the sample years. On the other hand, we did not find any overall systematic pattern in the regional coefficients. The regional hierarchy of pay does seem to be fairly stable relative to Greater London, though the coefficients show significant movements at times.

Now that we are aware of the change in coefficients, we need to assess the impact of these changes on the growth of real wages between 1978 and 1985. We illustrated in Section 5.4, that the change in real wages may be decomposed into changes in the coefficients and changes in the characteristics of the sample. Therefore we must also examine the effect of the latter.

The last row of Table 5.5.8 gives the mean of the dependent variable, the log of the real gross wage, for each year in our sample. Since these numbers are given in logs, the difference between any two numbers on this row is the percentage change in average real gross wages. (We must note that this average is the geometric average of real gross wages and therefore lower than the arithmetic means given in Table A5.3) The last row of Table 5.5.8 indicates that average real wages rose by nearly 22 per cent between 1978 and 1985 in our FES samples.

This table illustrates how we can use Oaxaca's methodology to decompose the change in average wages into the effect of changes in the coefficients, assuming constant sample means, and the effect of changes in the sample means, assuming constant coefficients.

Table 5.5.8

Predicted log wages

using coefficients from year i and sample from year j

Changing sample   Changing coefficients ——>

	1978	1979	1980	1981	1982	1983	1984	1985
1978	**1.124**	1.139	1.150	1.160	1.167	1.227	1.250	1.257
1979	1.134	**1.147**	1.158	1.173	1.171	1.260	1.285	1.294
1980	1.138	1.155	**1.163**	1.177	1.180	1.211	1.229	1.235
1981	1.151	1.167	1.177	**1.191**	1.192	1.233	1.254	1.266
1982	1.151	1.172	1.183	1.187	**1.227**	1.279	1.298	1.314
1983	1.145	1.164	1.176	1.181	1.211	**1.265**	1.284	1.294
1984	1.145	1.162	1.174	1.179	1.226	1.280	**1.296**	1.309
1985	1.152	1.173	1.186	1.187	1.235	1.288	1.308	**1.321**
	1.124	**1.147**	**1.163**	**1.191**	**1.227**	**1.265**	**1.296**	**1.321**

Reading along any given row of the table the sample means are fixed but the coefficients vary with the column year. On the other hand, reading down a column, the coefficients are fixed but the sample means vary with the row year. For instance, reading along the first row of this table we have the mean of the predicted wage calculated using the data for 1978 with the estimated coefficients given by the respective columns. Similarly, looking along the last column of the table we find the predicted wage using the coefficients for 1985 and the sample means given by the respective rows.

Therefore, the numbers on the diagonal correspond to the mean of the predicted wage for each year using the estimated coefficients for that year. We know from the properties of ordinary least squares, that these diagonal elements should equal the actual mean wage of the sample. Allowing for small numerical errors, the diagonal entries are roughly equal to the last row of the table which gives the actual sample means.

Consider Table 5.5.8; the changes in the predicted log wages are much greater when we move along a row than down a column. This implies that the increase in real wages can be explained primarily by changes in the coefficients rather than the changing characteristics of the sample. Given any row, the effect of the change in coefficients is substantial as we move from the 1978 column to the 1985 column, the increase is in the range of 14 to 16 per cent. Moving down any given column, the increase in predicted wages is smaller and in the range of 4 to 6 per cent. The increases in the real wage arising from the changing characteristics of the sample become more important from 1982 onwards.

Table 5.5.8 illustrates that at most 6 per cent of the 20 per cent increase in the average real gross wages of male employees in the FES samples between 1978 and 1985 can be accounted for by the change in the characteristics of the population. The rest, between 13 to 16 per cent, can be associated with the change in the market value of individual's educational, regional, occupational and industrial attributes.

In describing the data in Section 5.3 above we came across two noticeable changes in the characteristics of the data: the proportion of those staying in full-time education increased dramatically during the sample period and, secondly, there has been a significant rise in the proportion of managerial and administrative workers at the expense of the semi-skilled and unskilled employees. Either of these two changes in the structure of the population could explain the 3 to

6 per cent rise in the real wages attributed to the changes in the characteristics of the population. However, it is not immediately clear which variables are behind the much larger rise associated with the changing coefficients. Has the market value of education risen, have the regional imbalances contributed to wages inflation, does the rise in the real wage indicate shortages in certain occupational categories or is it the shift in the industrial structure of the economy which is behind the rise in the real wage? We now turn to investigating the contribution of each group of coefficient to the rise in the real wages.

Table 5.5.9

Predicted log wages

using educational coefficients from year i

and other coefficients and sample from year j

changing education coefficients ———>

	1978	1979	1980	1981	1982	1983	1984	1985
1978	**1.124**	1.162	1.164	1.155	1.145	1.180	1.198	1.189
1979	1.110	**1.147**	1.149	1.140	1.133	1.168	1.182	1.178
1980	1.124	1.162	**1.163**	1.154	1.147	1.180	1.196	1.191
1981	1.160	1.199	1.110	**1.191**	1.185	1.217	1.233	1.229
1982	1.196	1.233	1.236	1.223	**1.227**	1.276	1.280	1.286
1983	1.182	1.219	1.222	1.209	1.214	**1.265**	1.267	1.277
1984	1.213	1.250	1.252	1.241	1.245	1.293	**1.296**	1.306
1985	1.221	1.258	1.261	1.248	1.256	1.309	1.308	**1.321**
	1.124	1.147	1.163	1.191	1.227	1.265	1.296	1.320

The impact of changes in educational coefficients on log wages are presented in Table 5.5.9. This table, as well as all the subsequent tables exploring the impact of changing coefficients, should only be read along the rows and not down the columns. Reading across each row, we have constant sample means as in Table 5.5.8, however, only the educational coefficients change with the column year, all other coefficients are kept constant. Therefore moving along any row we isolate the effect of changes in the educational coefficients on log wages.

It is interesting to note that the year-on-year change in predicted log wages in each row of Table 5.5.9 exhibits a very similar pattern to the estimated educational coefficients presented in Table A5.4. Predicted log wages fluctuates from year to year but there is a distinct pattern. Looking across the rows of Table 5.5.9, we see a rise of between 5 to 10 per cent in the predicted wages as a consequence of changes in the educational coefficient. This is a very substantial proportion that was to be expected from our earlier finding that the returns to education rose significantly between 1978 and 1985.

The effect of changes in the occupational coefficients are presented in Table 5.5.10. Considering each row, there is again a very clear pattern: changes in the occupational coefficients account for 3 to 5 per cent of the rise in real wages in our sample between 1978 and 1985.

Table 5.5.10

Predicted log wages

using occupational coefficients from year i

and other coefficients and sample from year j

Changing occupation coefficients ———>

	1978	1979	1980	1981	1982	1983	1984	1985
1978	**1.124**	1.129	1.131	1.126	1.140	1.173	1.168	1.152
1979	1.143	**1.147**	1.149	1.143	1.160	1.192	1.188	1.172
1980	1.158	1.162	**1.163**	1.158	1.174	1.206	1.203	1.186
1981	1.189	1.194	1.196	**1.191**	1.206	1.241	1.233	1.218
1982	1.201	1.206	1.208	1.198	**1.227**	1.257	1.264	1.243
1983	1.206	1.211	1.212	1.203	1.235	**1.265**	1.273	1.251
1984	1.232	1.237	1.238	1.228	1.258	1.289	**1.296**	1.275
1985	1.274	1.279	1.281	1.272	1.303	1.334	1.341	**1.321**
	1.124	**1.147**	**1.163**	**1.191**	**1.227**	**1.265**	**1.296**	**1.320**

Turning to the regional coefficients, the effect of changes in these coefficients are presented in Table 5.5.11. In our cross-section analysis we observed a very stable regional hierarchy of pay and although we noted substantial variations from year to year, we could not detect any consistent rising or falling wage differentials over the eight years covered by our sample. A clearer picture is presented by Table 5.5.11. Our earlier deduction that wage differentials in 1985 seemed to be at the same level as 1978 is confirmed in Table 5.5.11. However, we can also observe a pattern: predicted wages rise by about 3 per cent between 1978 and 1982 as a consequence of changing regional coefficients; this rise is reversed between 1982 and 1985 so that predicted wages in 1985 return to the same level as 1978. In short, changes in regional coefficients were responsible for a 3 per cent rise in real wages between 1978 and 1982 and a 3 per cent fall in real wages between 1982 and 1985.

Table 5.5.11

Predicted log wages

using regional coefficients from year i

and other coefficients and sample from year j

changing regional coefficients ——>

	1978	1979	1980	1981	1982	1983	1984	1985
1978	**1.124**	1.167	1.120	1.144	1.150	1.101	1.102	1.120
1979	1.105	**1.147**	1.101	1.125	1.131	1.081	1.082	1.100
1980	1.166	1.209	**1.163**	1.186	1.192	1.143	1.143	1.161
1981	1.172	1.214	1.169	**1.191**	1.197	1.148	1.149	1.167
1982	1.199	1.243	1.197	1.220	**1.227**	1.178	1.179	1.196
1983	1.286	1.330	1.284	1.307	1.313	**1.265**	1.266	1.283
1984	1.316	1.361	1.315	1.338	1.345	1.296	**1.296**	1.314
1985	1.322	1.368	1.320	1.344	1.351	1.302	1.303	**1.321**
	1.124	1.147	1.163	1.191	1.227	1.265	1.296	1.321

The effect of changes in the industry coefficients are presented in Table 5.5.12. The alteration in the industrial classification between 1981 and 1982 make it necessary for us to consider the changes in industry coefficients separately for 1978-1981 and 1982-1985. Interestingly, the fall in the industry coefficients in 1980 is also observed here. Reading across the rows of Table 5.5.12 , we see that changes in the industrial coefficients were responsible for about 3 per cent rise in real wages between 1978 and 1981 and about another 3 per cent increase in real wages for the period 1982 and 1985 making a total of about 6 per cent over the whole period. Of course we cannot say anything about the contribution of changes in industry coefficients to wage inflation between 1981 and 1982. In discussing the cross-section results we noted that although a few industries experienced significant rises in their wage differentials, many of the other rises in estimated coefficients were not statistically significant. Therefore, we have to be very cautious in claiming that changes in industry coefficients caused a 6 per cent rise in real wages between 1978 and 1985, this is probably an over-estimate.

Table 5.5.12

Predicted log wages

using industry coefficients from year i

and other coefficients and sample from year j

changing industry coefficients ——>

	1978	1979	1980	1981	1982	1983	1984	1985
1978	**1.124**	1.149	1.105	1.170				
1979	1.123	**1.147**	1.105	1.171				
1980	1.182	1.206	**1.163**	1.219				
1981	1.161	1.166	1.123	**1.191**				
1982					**1.227**	1.195	1.249	1.255
1983					1.294	**1.265**	1.318	1.325
1984					1.272	1.241	**1.296**	1.302
1985					1.293	1.260	1.316	**1.321**
	1.124	**1.147**	**1.163**	**1.191**	**1.227**	**1.265**	**1.296**	**1.321**

5.6 Conclusion

The main aim of this chapter has been to contribute to the understanding of individual wage determination in an attempt to account for the substantial rise in real wages in Great Britain. With this aim in mind, we estimated a time series of cross-section wage equations from the Family Expenditure Survey for the period 1978-1985. For this period the FES provides very reliable data on earnings together with a consistent set of controls for family circumstances, educational attainment, occupation, region and industry.

Before estimating a full time series of cross-sections, we paid special attention to returns to education. The individuals in our sample have been affected by two changes in the statutory minimum school leaving age, once in 1947 and again in 1972. By estimating cross-section wage equations for the last three years of our sample, we tested whether it is the absolute or the relative level of education in comparison to the minimum school leaving age that matters when it comes to wage determination. The hypothesis that it is the absolute level of education that matters could not be rejected.

We then proceeded to estimate a full set of cross-section wage equation for the period 1978-1985. Our estimates indicated that not only the proportion of those staying in full-time education for longer periods steadily increased, but also the relative returns to education rose significantly during the sample period.

Between 1978 and 1985, the proportion of those in unskilled and semi-skilled occupations dropped significantly. We found that over the same period the returns to managerial, technical and administrative occupational categories relative to semi-skilled workers increased substantially while the returns to the teaching profession declined.

Our sample period also witnessed industrial change: a number of manufacturing industries such as metal extraction and vehicle production declined significantly while others such as distributive trades and insurance, banking and finance prospered. The estimated industry coefficients for a number of sectors also changed significantly.

Therefore, we had a picture of changing sample characteristics as well as significant changes in the estimated coefficients of our cross-section wage equations. To account for the change in real wages, we decomposed the rise in our dependent variable into two components: an element due to changes in the coefficients and another representing the effects of changes in the variables themselves. We found that between 4 to 6 percent of the 20 per cent increase in gross wages can be attributed to the changes in the characteristics of the data such as the shifts in the occupational, educational or industrial variables mentioned above. Changes in the coefficients were responsible for the other 14 to 16 per cent increase in real wages. In particular, changes in the occupational and educational coefficients played a significant part in the rise in real wages with a smaller contribution from changes in the industry coefficients.

Exploring the causes of the rise in the educational, occupational and industrial coefficients is beyond the scope of this study and probably needs a richer data set containing information on the individual's employer. However, we pointed out in our theoretical framework that educational and occupational characteristics broadly define a skill group, if the labour market returns to education and the market value of certain occupational categories have increased then this could indicate a problem of skill shortages.

APPENDIX

Table A5.1

FES Variables used in the analysis	
GEARN	Gross earnings of the individual in £ per week
GWAGE	Gross wages of the individual in £ per hour defined as Gross earnings divided by total hours worked
LRGWAGE	Log of real gross wages, log of GWAGE deflated by prices
AGE	Age of the individual
X	Experience defined as age minus age at which full-time education ceased
X1-X6	Experience splines, The first two are of length five years each and the next four are of length ten years each
DEP	Dummy indicating if the individual has any children under the age of 25 as dependents
MAR	Dummy indicating if the individual is married
E0ED	Dummy indicating if the individual left full-time education before the legal minimum age
E1ED14	Dummy indicating if the individual left full-time education at the minimum age of 14
ED15	Base group: Dummy indicating if the individual left full-time education at the age of 15
ED16	Dummy indicating if the individual left full-time education at the age of 16
ED1718	Dummy indicating if the individual left full-time at 17 or 18
ED1920	Dummy indicating if the individual left full-time at 19 or 20
ED21	Dummy indicating if the individual left full-time education at the age of 21 or above

Table A5.1 - continued

Regional Dummies

REG1	North
REG2	Yorkshire and Humberside
REG3	East Midlands
REG4	East Anglia
REG5	Base group: Greater London
REG6	South East except Greater London
REG7	South West
REG8	Wales
REG9	West Midlands
REG10	North West
REG11	Scotland

Occupational Dummies

OCC1	Professional and technical
OCC2	Administrative and managerial
OCC3	Teachers
OCC4	Clerical workers
OCC5	Shop assistants
OCC6	Skilled manual workers
OCC7	Base group: Semi-skilled manual workers
OCC8	Unskilled manual workers
DP1-DP8	Dummies indicating membership of professional body or union and in occupations OCC1 to OCC8 respectively

Industry Dummies

IND1–IND32	Industry dummies defined in Table A5.2

Table A5.2

FES Industrial categories

1982-85

IND1	Agriculture, forestry and fishing
IND2	Extraction, processing and production of coal, coke, mineral oil, natural gas and nuclear fuel
IND3	Gas, electricity and other forms of energy; water supply
IND4	Metal extraction and manufacture
IND5	Extraction of minerals nes: manufacture of non-metallic mineral products
IND6	Chemicals and allied industries; production of man-made fibres
IND7	Mechanical engineering; manufacture of metal goods nes
IND8	Electrical and electronic engineering; office machinery
IND9	Manufacture of vehicles, inc. parts, and other transport equipment
IND10	Instrument engineering
IND11	Food, drink and tobacco manufacture
IND12	Textiles
IND13	Leather and leather goods (combined with 12 to avoid small sample)
IND14	Clothing, footwear, household textiles and fur
IND15	Timber, furniture etc
IND16	Paper, printing and publishing
IND17	Processing of rubber and plastic; other manufacturing industries
IND18	Construction
IND19	Distributive trades, wholesale and retail
IND20	Hotels and catering

Table A5.2 - continued

IND21	Repair of consumer goods and vehicles
IND22	Rail transport
IND23	Other transport and misc. transport services
IND24	Postal services and communications
IND25	Insurance, banking, finance, real estate and business services
IND26	Justice; social security; national defence; national government nes; diplomatic representation and international organisations
IND27	Police and fire service
IND28	Sanitary services; local government service nes
IND29	Education; research and development
IND30	Medical, other health and veterinary services; other services provided to the general public
IND31	Recreational and cultural services
IND32	Personal and domestic services

Table A5.2 - continued

1978-1981

IND1	Agriculture, forestry and fishing
IND2	Coal and petroleum products
IND3	Gas, electricity and water
IND4	Metal manufacture
IND5	Mining and quarrying
IND6	Chemicals and allied industries
IND7	Mechanical engineering and metal goods nes
IND8	Electrical engineering
IND9	Shipbuilding and marine engineering and vehicles
IND10	Instrument engineering
IND11	Food, drink and tobacco
IND12	Textiles
IND13	Leather, leather goods and fur (combined with 12 to avoid small sample)
IND14	Clothing and footwear
IND15	Timber, furniture etc
IND16	Paper, printing and publishing
IND17	Bricks, pottery, glass, cement etc.
IND18	Construction
IND19	Distributive trades, wholesale and retail
IND20	-
IND21	Miscellaneous services (eg laundries, filling stations)
IND22	Rail transport
IND23	Other transport and communications, Post Office
IND24	-
IND25	Insurance, banking, finance and business services
IND26	Armed forces (not police or fire service)

Table A5.2 - continued

IND27	Local government service (police and fire service only)
IND28	Local government service (other than police and fire service)
IND29	Professional and scientific services
IND30	-
IND31	Miscellaneous services other than IND21 above
IND32	-

Industry specific variables from the Census of Production

CR	Five firm concentration ratio by employment
PNOP	Proportion of the industry employment that is clerical, technical and skilled
PCM	Price cost margin = (value-added - wages)/value added
ICE	Import-export competition = (imports - exports) /(imports + exports)
PCE	Proportionate change in employment = log employment in 1985 - log employment in 1984

Table A5.3

<u>Means and standard deviation of the data</u>

(standard deviations are give below each mean value)

	1978	1979	1980	1981	1982	1983	1984	1985
GEARN	77767	90998	107347	119605	143051	156091	165689	182169
	30618	38651	44479	54400	69467	77836	83274	99572
GWAGE	1752.9	2017.0	2422.6	2741.8	3379.5	3670.0	3902.6	4281.6
	942.9	875.51	1038.2	1242.1	1710.1	1943.4	2257.9	3009.3
LRGWAGE	1.1242	1.1470	1.1631	1.1914	1.2667	1.2646	1.2964	1.3204
	0.3792	0.3903	0.3921	0.4052	0.4567	0.4732	0.4704	0.5013
AGE	38.081	37.173	38.110	37.218	38.069	38.058	38.753	37.974
	13.733	13.390	13.439	13.448	12.823	12.575	12.860	12.647
X	22.708	21.691	22.616	21.716	21.968	21.847	22.569	21.646
	14.507	14.141	14.185	14.214	13.702	13.414	13.693	13.453
DEP	0.5228	0.5489	0.5507	0.5089	0.5195	0.5142	0.4950	0.4755
	0.4996	0.4977	0.4975	0.5000	0.4997	0.4999	0.5000	0.4995
MAR	0.7359	0.7310	0.7509	0.7185	0.7499	0.7429	0.7396	0.7245
	0.4409	0.4435	0.4326	0.4498	0.4331	0.4371	0.4389	0.4468
E0ED	0.0583	0.0459	0.0469	0.0546	0.0333	0.0372	0.0366	0.0430
	0.2343	0.2093	0.2114	0.2273	0.1794	0.1894	0.1878	0.2029
E1ED14	0.2590	0.2193	0.2187	0.1997	0.1655	0.1412	0.1372	0.1111
	0.4382	0.4139	0.4134	0.3998	0.3717	0.3483	0.3441	0.3144
ED15	0.3433	0.3602	0.3480	0.3358	0.2967	0.2789	0.2799	0.2739
	0.4749	0.4801	0.4764	0.4723	0.4569	0.4485	0.4490	0.4460
ED16	0.2198	0.2442	0.2570	0.2891	0.2822	0.3021	0.3021	0.3141
	0.4141	0.4297	0.4371	0.4534	0.4501	0.4592	0.4592	0.4642
ED17	0.0443	0.0465	0.0479	0.0474	0.0670	0.0690	0.0781	0.0692
	0.2059	0.2107	0.2136	0.2124	0.2501	0.2534	0.2684	0.2539
ED18	0.0326	0.0341	0.0342	0.0315	0.0492	0.0590	0.0597	0.0645
	0.1777	0.1815	0.1818	0.1746	0.2163	0.2357	0.2369	0.2457
ED19	0.0076	0.0121	0.0099	0.0073	0.0143	0.0166	0.0138	0.0160
	0.0869	0.1094	0.0991	0.0851	0.1186	0.1276	0.1168	0.1255
ED20	0.0025	0.0064	0.0048	0.0066	0.0097	0.0105	0.0114	0.0132
	0.0503	0.0796	0.0691	0.0811	0.0983	0.1019	0.1061	0.1143
ED21	0.0383	0.0376	0.0356	0.0325	0.0839	0.0855	0.0811	0.0949
	0.2197	0.2213	0.2012	0.2000	0.2841	0.2797	0.2730	0.2931
REG1	0.0779	0.0657	0.0739	0.0676	0.0559	0.0535	0.0575	0.059
	0.2681	0.2477	0.2617	0.251	0.2297	0.2251	0.2328	0.2357

Table A5.3 - continued

REG2	0.0925	0.0998	0.0938	0.0987	0.0858	0.0996	0.0938	0.0891
	0.2897	0.2998	0.2916	0.2983	0.2801	0.2995	0.2917	0.2849
REG3	0.0798	0.0762	0.0664	0.0742	0.0870	0.0775	0.0865	0.0838
	0.2710	0.2653	0.2490	0.2621	0.2819	0.2674	0.2812	0.2772
REG4	0.0345	0.0389	0.0353	0.0348	0.0359	0.0356	0.0323	0.0400
	0.1826	0.1934	0.1844	0.1832	0.1861	0.1853	0.1768	0.1960
REG5	0.1026	0.1033	0.1044	0.1036	0.1134	0.1095	0.1009	0.0998
	0.3035	0.3044	0.3058	0.3048	0.3171	0.3123	0.3012	0.2998
REG6	0.1694	0.1619	0.1725	0.1798	0.1992	0.2052	0.2145	0.2013
	0.3752	0.3685	0.3779	0.3841	0.3995	0.4039	0.4106	0.4010
REG7	0.0687	0.0743	0.0726	0.0629	0.0735	0.0665	0.0732	0.0869
	0.2530	0.2623	0.2594	0.2428	0.2609	0.2492	0.2605	0.2817
REG8	0.0500	0.0580	0.0589	0.0550	0.0528	0.0472	0.0529	0.0477
	0.2180	0.2338	0.2354	0.2280	0.2236	0.2120	0.2238	0.2132
REG9	0.1099	0.1077	0.1003	0.1013	0.0977	0.1059	0.0995	0.0949
	0.3128	0.3101	0.3004	0.3018	0.2970	0.3078	0.2994	0.2931
REG10	0.1023	0.1148	0.1222	0.1189	0.1155	0.1150	0.1020	0.1018
	0.3031	0.3188	0.3275	0.3237	0.3197	0.3191	0.3027	0.3024
REG11	0.1124	0.0995	0.0999	0.0907	0.0832	0.0844	0.0868	0.0957
	0.3159	0.2993	0.3000	0.2873	0.2762	0.278	0.2816	0.2942
OCC1	0.0617	0.0660	0.0667	0.0583	0.1260	0.1448	0.1302	0.1426
	0.2407	0.2483	0.2496	0.2343	0.3319	0.3520	0.3366	0.3497
OCC2	0.0586	0.0784	0.0691	0.0649	0.1358	0.1523	0.1432	0.1506
	0.2349	0.2689	0.2537	0.2464	0.3426	0.3593	0.3503	0.3577
OCC3	0.0104	0.0137	0.0178	0.0063	0.0395	0.0383	0.0355	0.0328
	0.1017	0.1163	0.1322	0.0791	0.1947	0.1921	0.1851	0.1782
OCC4	0.0535	0.0510	0.0489	0.0566	0.0777	0.0866	0.0819	0.0794
	0.2251	0.2200	0.2158	0.2312	0.2678	0.2813	0.2743	0.2704
OCC5	0.0079	0.0102	0.0120	0.0083	0.0088	0.0149	0.0127	0.0094
	0.0886	0.1005	0.1088	0.0906	0.0934	0.1212	0.1122	0.0964
OCC6	0.5028	0.4820	0.5003	0.5285	0.3954	0.3741	0.3876	0.3806
	0.5001	0.4998	0.5001	0.4993	0.4890	0.4839	0.4873	0.4856
OCC8	0.0636	0.0577	0.0575	0.0593	0.0426	0.0323	0.0475	0.0422
	0.2442	0.2332	0.2328	0.2362	0.2019	0.1768	0.2127	0.2011
OCC7	0.2413	0.2410	0.2276	0.2179	0.1740	0.1567	0.1614	0.1624
	0.4279	0.4278	0.4193	0.4129	0.3792	0.3636	0.3679	0.3689
IND1	0.0225	0.0271	0.0192	0.0265	0.0183	0.0171	0.0133	0.0237
	0.1483	0.1624	0.1371	0.1606	0.1341	0.1297	0.1145	0.1522

Table A5.3 - continued

IND2	0.0038	0.0057	0.0044	0.0050	0.0402	0.0240	0.0304	0.0303
	0.0615	0.0755	0.0666	0.0703	0.1964	0.1531	0.1716	0.1715
IND3	0.0222	0.0274	0.0209	0.0275	0.0212	0.0290	0.0247	0.0223
	0.1472	0.1633	0.1430	0.1635	0.1439	0.1677	0.1552	0.1478
IND4	0.0304	0.0370	0.0387	0.0377	0.0226	0.0163	0.0152	0.0121
	0.1717	0.1887	0.1928	0.1906	0.1486	0.1266	0.1223	0.1095
IND5	0.0279	0.0335	0.0270	0.0493	0.0159	0.0160	0.0179	0.0154
	0.1646	0.1799	0.1622	0.2166	0.1252	0.1255	0.1326	0.1233
IND6	0.0291	0.0281	0.0250	0.0301	0.0290	0.0259	0.0282	0.0284
	0.1682	0.1651	0.1561	0.1710	0.1678	0.1590	0.1656	0.1662
IND7	0.0985	0.0787	0.0883	0.0752	0.0832	0.0759	0.0754	0.0745
	0.2980	0.2694	0.2838	0.2637	0.2762	0.2648	0.2641	0.2626
IND8	0.0377	0.0398	0.0407	0.0348	0.0440	0.0472	0.0472	0.0400
	0.1905	0.1956	0.1977	0.1832	0.2051	0.2120	0.2121	0.1960
IND9	0.0975	0.0724	0.0880	0.0752	0.0611	0.0491	0.0526	0.0483
	0.2967	0.2591	0.2833	0.2637	0.2395	0.2161	0.2233	0.2144
IND10	0.0054	0.0051	0.0058	0.0070	0.0059	0.0047	0.0041	0.0030
	0.0732	0.0712	0.0761	0.0831	0.0769	0.0683	0.0637	0.0550
IND11	0.0351	0.0322	0.0305	0.0411	0.0376	0.0331	0.0344	0.0347
	0.1842	0.1765	0.1719	0.1985	0.1902	0.1789	0.1824	0.1832
IND12	0.0269	0.0185	0.0188	0.0142	0.0076	0.0116	0.0119	0.0108
	0.1619	0.1347	0.1359	0.1185	0.0869	0.1070	0.1086	0.1032
IND14	0.0063	0.0083	0.0065	0.0053	0.0067	0.0119	0.0081	0.0066
	0.0793	0.0907	0.0804	0.0726	0.0813	0.1083	0.0898	0.0811
IND15	0.0184	0.0156	0.0185	0.0169	0.0176	0.0121	0.0138	0.0152
	0.1343	0.1240	0.1347	0.1289	0.1315	0.1095	0.1168	0.1222
IND16	0.0301	0.0338	0.0315	0.0288	0.0314	0.0309	0.0309	0.0270
	0.1708	0.1807	0.1747	0.1673	0.1744	0.1731	0.1731	0.1622
IND17	0.0171	0.0194	0.0175	0.0149	0.0181	0.0188	0.0179	0.0149
	0.1297	0.1381	0.1310	0.1212	0.1332	0.1357	0.1326	0.1211
IND18	0.1235	0.1167	0.1157	0.1070	0.0868	0.0847	0.0960	0.0965
	0.3291	0.3211	0.3199	0.3091	0.2815	0.2785	0.2946	0.2954
IND19	0.0662	0.0819	0.0842	0.0748	0.0944	0.1167	0.1050	0.0982
	0.2486	0.2743	0.2777	0.2632	0.2924	0.3211	0.3065	0.2976
IND20					0.0121	0.0116	0.0160	0.0130
					0.1095	0.107	0.1255	0.1131
IND21	0.0263	0.0338	0.0277	0.0338	0.0136	0.0152	0.0157	0.0138
	0.1600	0.1807	0.1642	0.1807	0.1156	0.1223	0.1244	0.1166

Table A5.3 - continued

IND22	0.0171	0.0242	0.0185	0.0245	0.0128	0.0105	0.0146	0.0088
	0.1297	0.1538	0.1347	0.1546	0.1126	0.1019	0.1201	0.0935
IND23	0.1482	0.1635	0.1762	0.1606	0.0468	0.0532	0.0429	0.0455
	0.3553	0.3699	0.3811	0.3672	0.2113	0.2245	0.2026	0.2084
IND24					0.0278	0.0287	0.0266	0.0350
					0.1645	0.1670	0.1609	0.1839
IND25	0.0288	0.0274	0.0281	0.0262	0.0625	0.0720	0.0768	0.0838
	0.1673	0.1633	0.1652	0.1596	0.2421	0.2585	0.2662	0.2772
IND26	0.0218	0.0207	0.0212	0.0285	0.0319	0.0320	0.0290	0.0364
	0.1462	0.1425	0.1441	0.1664	0.1756	0.1760	0.1679	0.1873
IND27	0.0123	0.0134	0.0079	0.0129	0.0183	0.0166	0.0174	0.0223
	0.1105	0.1150	0.0884	0.1129	0.1341	0.1276	0.1306	0.1478
IND28	0.0209	0.0249	0.0233	0.0255	0.0326	0.0301	0.0355	0.0356
	0.1431	0.1557	0.1508	0.1577	0.1775	0.1708	0.1851	0.1853
IND29	0.0538	0.0500	0.0537	0.0440	0.0533	0.0566	0.0502	0.0483
	0.2257	0.2181	0.2255	0.2052	0.2246	0.2310	0.2183	0.2144
IND30					0.0281	0.0320	0.0317	0.0347
					0.1652	0.1760	0.1753	0.1832
IND31	0.0237	0.0287	0.0305	0.0341	0.0143	0.0121	0.0122	0.0168
	0.1523	0.1670	0.1719	0.1815	0.1186	0.1095	0.1098	0.1286
					0.0043	0.0047	0.0043	0.0039
					0.0653	0.0683	0.0657	0.0620
DP1	0.0063	0.0035	0.0048	0.0043	0.0181	0.0629	0.0572	0.0593
	0.0793	0.0591	0.0691	0.0655	0.1332	0.2428	0.2323	0.2362
DP2	0.0047	0.0054	0.0041	0.0043	0.0119	0.0425	0.0437	0.0452
	0.0688	0.0734	0.0640	0.0655	0.1084	0.2017	0.2044	0.2078
DP3	0.0010	0.0038	0.0051	0.0013	0.0121	0.0212	0.0231	0.0207
	0.0308	0.0617	0.0715	0.0364	0.1095	0.1442	0.1501	0.1423
DP4	0.0028	0.0013	0.0021	0.0036	0.0040	0.0381	0.0334	0.0306
	0.0533	0.0357	0.0453	0.0603	0.0635	0.1914	0.1796	0.1723
DP5		0.0003			0.0002	0.0014	0.0019	0.0017
		0.0179			0.0154	0.0371	0.0435	0.0407
DP6	0.0044	0.0029	0.0041	0.0043	0.0045	0.1603	0.1649	0.1773
	0.0664	0.0535	0.0640	0.0655	0.0671	0.3669	0.3711	0.3820
DP7	0.0016	0.0010	0.0014	0.0026	0.0005	0.0701	0.0784	0.0717
	0.0398	0.0309	0.0370	0.0514	0.0218	0.2553	0.2688	0.2580
DP8	0.0003	0.0006	0.0007			0.0163	0.0228	0.0154
	0.0178	0.0252	0.0262			0.1266	0.1492	0.1233

A5.4

<u>Ordinary Least Squares Estimates of the Wage Equations 1978-1985</u>
(standard errors are given immediately below each estimate)

	1978	1979	1980	1981	1982	1983	1984	1985
X1	0.1452	0.1397	0.1463	0.1401	0.1256	0.1244	0.1229	0.1292
	0.0078	0.0078	0.0089	0.0079	0.0086	0.0095	0.0093	0.0095
X2	0.0051	0.0072	0.0153	0.0109	0.0279	0.0186	0.0208	0.0111
	0.0065	0.0063	0.0069	0.0062	0.0062	0.0069	0.0067	0.0070
X3	0.0033	0.0065	0.0046	0.0079	0.0118	0.0147	0.0144	0.0161
	0.0027	0.0026	0.0029	0.0027	0.0025	0.0028	0.0029	0.0031
X4	0.0030	0.0001	-0.0020	0.0013	-0.0030	-0.000	-0.000	0.0026
	0.0027	0.0027	0.0027	0.0026	0.0023	0.0025	0.0025	0.0028
X5	-8E-05	-0.003	0.0021	0.0008	0.0064	0.0036	-0.002	0.0044
	0.003	0.0032	0.0035	0.0036	0.0032	0.0035	0.0033	0.0038
X6	-0.009	-0.009	-0.012	-0.011	-0.013	-0.011	-0.016	-0.01
	0.0034	0.0039	0.004	0.0041	0.0037	0.0043	0.004	0.0045
E0ED	-0.058	-0.024	-0.055	-0.035	-0.042	0.0084	0.0223	-0.003
	0.0244	0.0269	0.0284	0.0256	0.0289	0.0301	0.0305	0.031
E1ED14	-0.089	-0.02	-0.007	-0.031	-0.084	-0.039	0.026	-0.043
	0.0214	0.0236	0.0255	0.0262	0.0237	0.0274	0.0268	0.032
ED16	0.0093	0.0768	0.0774	0.0668	0.066	0.0757	0.1123	0.1137
	0.0167	0.0167	0.0177	0.0168	0.0152	0.0169	0.0167	0.0184
ED1718	0.0977	0.1278	0.0805	0.1285	0.1007	0.1505	0.1522	0.2223
	0.0227	0.0228	0.0239	0.0239	0.0194	0.0212	0.0204	0.0233
ED1920	0.0959	0.1911	0.2414	0.1479	0.1998	0.5445	0.3416	0.4472
	0.0751	0.0664	0.0811	0.0773	0.0667	0.081	0.0891	0.0929
ED21	0.2486	0.2445	0.3269	0.2019	0.3798	0.654	0.5006	0.5947
	0.0451	0.0418	0.0656	0.0565	0.0573	0.078	0.0876	0.0913
REG1	-0.107	-0.06	-0.122	-0.075	-0.076	-0.147	-0.175	-0.155
	0.0249	0.0266	0.0275	0.0264	0.0256	0.0288	0.0281	0.0306
REG2	-0.109	-0.115	-0.138	-0.065	-0.088	-0.175	-0.15	-0.124
	0.0237	0.0237	0.0259	0.0238	0.0224	0.0242	0.0245	0.0275
REG3	-0.154	-0.064	-0.144	-0.11	-0.072	-0.147	-0.153	-0.151
	0.0245	0.0254	0.0286	0.026	0.0226	0.0258	0.025	0.0281
REG4	-0.161	-0.085	-0.169	-0.107	-0.098	-0.128	-0.154	-0.151
	0.0321	0.0314	0.0347	0.0331	0.0297	0.033	0.0342	0.0348
REG6	-0.081	-0.002	-0.046	-0.049	-0.037	-0.058	-0.069	-0.045
	0.0205	0.021	0.0223	0.0202	0.0183	0.0203	0.0204	0.0226

Table A5.4 - continued

REG7	-0.176	-0.095	-0.196	-0.131	-0.096	-0.168	-0.155	-0.136
	0.0255	0.0253	0.0273	0.0266	0.0234	0.0268	0.0259	0.0271
REG8	-0.127	-0.095	-0.096	-0.113	-0.103	-0.193	-0.206	-0.134
	0.0285	0.0274	0.0298	0.0282	0.0262	0.0299	0.0291	0.0327
REG9	-0.1	-0.074	-0.113	-0.108	-0.122	-0.185	-0.168	-0.145
	0.023	0.0234	0.0255	0.0235	0.0218	0.0237	0.0241	0.027
REG10	-0.103	-0.07	-0.118	-0.104	-0.093	-0.148	-0.142	-0.157
	0.023	0.0227	0.024	0.0223	0.0208	0.0231	0.0239	0.0263
REG11	-0.1	-0.071	-0.134	-0.101	-0.097	-0.13	-0.117	-0.084
	0.0224	0.0235	0.0252	0.024	0.0226	0.0249	0.0248	0.0266
OCC1	0.2843	0.3032	0.2836	0.343	0.3826	0.38	0.4225	0.4414
	0.0262	0.026	0.0277	0.0279	0.0215	0.029	0.0302	0.0319
OCC2	0.2571	0.2616	0.3033	0.2059	0.3316	0.3823	0.4129	0.3812
	0.0256	0.0236	0.0261	0.0259	0.0198	0.0262	0.0269	0.0286
OCC3	0.512	0.5162	0.4329	0.348	0.4508	0.3858	0.5753	0.4056
	0.0626	0.0658	0.0568	0.0799	0.048	0.0576	0.0625	0.0677
OCC4	0.0962	0.0872	0.1096	0.1124	0.1209	0.2017	0.1852	0.1116
	0.0258	0.0267	0.0291	0.0272	0.0224	0.0318	0.0318	0.0346
OCC5	0.1357	0.0239	-0.106	-0.041	0.0191	-0.059	0.0044	-0.119
	0.0597	0.0561	0.0539	0.0624	0.0561	0.052	0.0567	0.0707
OCC6	0.0617	0.0716	0.0735	0.0741	0.0793	0.1231	0.0999	0.0883
	0.0134	0.0138	0.0147	0.0146	0.0149	0.0228	0.0232	0.0252
OCC8	-0.038	-0.043	-0.043	-0.078	-0.091	-0.003	-0.005	-0.036
	0.0233	0.0248	0.0266	0.0256	0.027	0.0467	0.0394	0.0415
DP1	0.2814	0.1703	0.2623	0.2247	0.0994	0.1276	0.0955	0.0263
	0.068	0.0925	0.0837	0.0855	0.0393	0.0293	0.0301	0.0322
DP2	-0.037	0.0216	0.0465	0.1989	0.2172	0.1263	0.1005	0.0772
	0.0776	0.0741	0.0896	0.0859	0.0471	0.0314	0.0313	0.0333
DP3	-0.019	-0.033	-0.134	0.1657	0.0846	0.0848	-0.009	0.0179
	0.2093	0.101	0.0934	0.1664	0.0533	0.0551	0.0592	0.0658
DP4	-0.045	0.0714	-0.007	-0.01	-0.025	0.0535	0.07	0.0573
	0.0999	0.1479	0.1269	0.0921	0.079	0.0373	0.0383	0.0424
DP5	——	-0.062	——	——	0.4474	0.0472	0.0344	0.1775
		0.2957			0.3181	0.1505	0.1319	0.155
DP6	0.1502	0.1924	0.0505	0.0198	0.1418	0.0696	0.0856	0.1004
	0.0767	0.0979	0.0872	0.0823	0.0727	0.0186	0.0186	0.0199
DP7	0.0644	0.4929	-0.087	0.0675	-0.018	0.1222	0.1051	0.0792
	0.1281	0.1696	0.1504	0.1044	0.2236	0.0284	0.0278	0.0306

Table A5.4 - continued

DP8	0.3991	-0.1	0.2835	——	——	0.059	0.0388	0.0764
	0.2851	0.2079	0.2142			0.0603	0.0494	0.0587
IND2	0.4202	0.3193	0.3997	0.4755	0.5587	0.4605	0.5174	0.5163
	0.0866	0.0739	0.0889	0.0806	0.0445	0.0558	0.0575	0.0532
IND3	0.2197	0.3353	0.3121	0.394	0.4477	0.4076	0.45	0.4611
	0.0435	0.0412	0.0489	0.0426	0.0499	0.054	0.0592	0.0571
IND4	0.2764	0.2593	0.196	0.3251	0.3421	0.3596	0.3657	0.345
	0.0402	0.0386	0.0419	0.0394	0.0492	0.0606	0.0649	0.0675
IND5	0.3962	0.4163	0.373	0.4956	0.2721	0.2337	0.3185	0.279
	0.0413	0.0399	0.0463	0.0377	0.0532	0.0608	0.0627	0.0619
IND6	0.2476	0.2915	0.1985	0.2733	0.3735	0.3668	0.4468	0.405
	0.0401	0.041	0.0464	0.0414	0.0464	0.0544	0.0576	0.0536
IND7	0.1756	0.2355	0.159	0.1985	0.2529	0.2399	0.3016	0.3226
	0.0316	0.0325	0.0356	0.0338	0.0405	0.0469	0.0518	0.0461
IND8	0.1513	0.2006	0.1299	0.2234	0.2923	0.2866	0.3224	0.3723
	0.0376	0.0372	0.0409	0.0398	0.0435	0.0495	0.0536	0.0503
IND9	0.2294	0.2664	0.1737	0.2658	0.3282	0.2927	0.3441	0.3042
	0.0317	0.0328	0.0355	0.0337	0.0415	0.0495	0.0535	0.0491
IND10	0.1046	0.0816	0.1835	0.2189	0.2471	0.2123	0.3909	0.2516
	0.076	0.0777	0.0785	0.0698	0.0729	0.0887	0.0956	0.1124
IND11	0.1967	0.2229	0.1803	0.2188	0.265	0.159	0.2952	0.3235
	0.038	0.039	0.0438	0.0379	0.0442	0.0518	0.0554	0.0506
IND12	0.1469	0.1802	0.0838	0.1298	0.2307	0.1649	0.2183	0.2045
	0.041	0.0467	0.0505	0.0523	0.0667	0.0657	0.0679	0.0692
IND14	0.1827	0.1735	0.0707	0.0709	0.1443	0.1036	0.2503	0.264
	0.0695	0.0632	0.0753	0.0783	0.0699	0.0656	0.0756	0.0814
IND15	0.1513	0.1622	0.0839	0.1117	0.2121	0.0609	0.2464	0.2236
	0.0466	0.0496	0.0507	0.0497	0.052	0.0648	0.0658	0.0625
IND16	0.2445	0.2527	0.2324	0.2941	0.38	0.3624	0.3551	0.4494
	0.04	0.0391	0.0437	0.0421	0.0461	0.0528	0.0569	0.0543
IND17	0.1763	0.2472	0.139	0.2493	0.2165	0.1924	0.2303	0.32
	0.0473	0.0458	0.0516	0.0515	0.0513	0.0575	0.0617	0.0622
IND18	0.1502	0.1387	0.114	0.1522	0.2065	0.2217	0.2952	0.2715
	0.0309	0.0308	0.0344	0.0324	0.0404	0.0468	0.051	0.0448
IND19	-0.093	-0.123	-0.109	-0.132	0.1031	0.1057	0.1634	0.1824
	0.0273	0.0265	0.0272	0.0277	0.0402	0.0457	0.0507	0.0446
IND20	——	——	——	——	-0.005	-0.068	0.062	-0.011
					0.0569	0.0648	0.0624	0.064

Table A5.4 - continued

IND21	-0.037	-0.01	-0.091	-0.03	0.0844	0.1479	0.0838	0.1053
	0.0419	0.0393	0.0452	0.0402	0.0559	0.0618	0.0644	0.0645
IND22	0.1272	0.1741	0.0635	0.1603	0.2081	0.2159	0.243	0.231
	0.0477	0.0431	0.051	0.044	0.0567	0.0678	0.0654	0.0744
IND23	0.1176	0.1291	0.1153	0.1793	0.2004	0.1948	0.1823	0.1835
	0.0323	0.0323	0.0355	0.0332	0.0433	0.0491	0.0547	0.0495
IND24	——	——	——	——	0.3899	0.3343	0.408	0.3903
					0.0467	0.0536	0.0582	0.0517
IND25	0.2347	0.2704	0.1371	0.3407	0.3689	0.2947	0.4019	0.3684
	0.042	0.0427	0.0469	0.0452	0.0425	0.0482	0.0523	0.0466
IND26	0.1072	0.1716	0.1708	0.2266	0.3179	0.1944	0.2224	0.2677
	0.0438	0.0455	0.0491	0.0422	0.046	0.053	0.0574	0.0514
IND27	0.2637	0.4052	0.3533	0.5128	0.5456	0.5279	0.5516	0.5354
	0.0537	0.053	0.07	0.0554	0.052	0.061	0.0638	0.058
IND28	0.0998	0.114	0.1208	0.1421	0.3139	0.1992	0.2157	0.2673
	0.0446	0.0426	0.0477	0.0436	0.0459	0.0537	0.056	0.0519
IND29	0.0132	0.0182	0.0872	0.1105	0.2288	0.2478	0.225	0.2633
	0.0365	0.0385	0.0411	0.0385	0.052	0.0551	0.0601	0.057
IND30	——	——	——	——	0.1066	0.0055	0.1042	0.1064
					0.0472	0.0529	0.0572	0.0518
IND31	-0.112	-0.021	-0.119	0.037	0.0986	0.059	0.1595	0.2184
	0.0424	0.0405	0.044	0.0396	0.0549	0.0642	0.0678	0.0599
IND32	——	——	——	——	-0.212	0.0388	0.0363	0.0264
					0.0826	0.0885	0.0926	0.0997
MAR	0.0521	0.081	0.0609	0.0806	0.057	0.091	0.1178	0.0757
	0.0155	0.0161	0.0174	0.0165	0.0153	0.0167	0.0164	0.0178
DSDEP	0.0047	0.021	0.0396	0.023	0.0024	0.0088	0.019	0.0344
	0.0122	0.0125	0.0134	0.0126	0.0119	0.0129	0.0132	0.0138
UX1	-0.029	-0.017	-0.044	-0.021	-0.036	-0.077	-0.054	-0.066
	0.0178	0.0177	0.0211	0.0219	0.0167	0.0204	0.0223	0.0234
UX2	0.025	0.0146	0.0223	0.0534	0.0175	0.0177	0.0282	0.0118
	0.0198	0.0189	0.0225	0.0224	0.0134	0.0145	0.0145	0.0155
UX3	0.0231	-0.006	-0.008	-0.018	0.0053	0.0063	0.0006	0.0215
	0.0128	0.0114	0.013	0.0141	0.0069	0.0072	0.0074	0.0075
UX4	-0.015	0.0379	0.0052	0.046	-0.001	0.0065	-0.006	-0.012
	0.0181	0.0159	0.0146	0.0191	0.0093	0.0096	0.0099	0.0094
UX5	-0.077	-0.052	0.0147	0.0063	0.0389	-0.018	0.015	0.013
	0.0236	0.0177	0.0205	0.0299	0.0169	0.018	0.0212	0.0163

Table A5.4 - continued

UX6	0.0501	-0.017	——	——	-0.053	-0.346	-0.082	0.0236
	0.1113	0.0601			0.1125	0.117	0.183	0.0863
N	3153	3135	2921	3020	4206	3625	3689	3625
F-value	36.8	37	32.1	42.9	64.8	58.7	58.3	55.2
Root MS	0.283	0.2896	0.2976	0.2906	0.3134	0.3195	0.3197	0.344
Adj R-s	0.443	0.4495	0.4239	0.4858	0.5289	0.5442	0.5381	0.5288
SEE	0.08	0.0839	0.0886	0.0844	0.0982	0.102	0.1021	0.1184

—— indicates that there were no observations in this category.

Conclusion

Conclusion

This thesis has been devoted to the study of wages. We have looked at wages from the macro level to the individual level using a variety of econometric techniques. Our study has not been confined to the UK but has also looked overseas, to the continent and the United States. Our effort would have been to no avail were we not able to draw some conclusions with regard to the implications of the results for economic policy. The results of our study are discussed in detail in individual chapters. In this conclusion we shall simply outline some of the main results before, at the risk of becoming polemic, discussing policy implications in greater detail.

Initially we presented a survey of the theories of wage determination. Most models imply the joint determination of wages and employment. Furthermore, they have broadly similar implications regarding the host of variables which enter a wage equation although they may differ about the variables which enter an employment equation. From this basis we undertook an empirical study of the determinants of earnings in the United Kingdom using time series data. We obtained a robust long-run equation for wages relating average earnings to short-term unemployment, productivity, mismatch, direct and indirect taxes.

Unemployment, which persisted throughout the 1980s, was a scourge that confounded the policy makers. Traditionally, unemployment has been thought to exert downward pressure on wages. However, our empirical results imply a very weak link between unemployment and real wages. Not only do the long-term unemployed exert no downward pressure on wages in the UK, but also the short-term unemployed have a negligible effect: a one per cent increase in their numbers only leads to a 0.03 per cent decrease in real wages. This means that if short term unemployment stood at 1.5 million and average earnings were £200 a week then unemployment would have to rise to about 2 million before wages fell to £198.

We also found that real wages could increase in line with increases in productivity: a one per cent rise in productivity leads to an equal increase in earnings. In the early 1980s above average productivity increases in the UK meant that firms could 'afford' to award pay increases. However, once productivity gains declined, high pay awards led to worsening unit labour costs relative to the UK's competitors. Despite rapid growth in the 1980s, productivity in the UK still lags behind her competitors: Ford workers in the UK take an average of 77 hours to build a car, their German counterparts take just 48 hours. High productivity means that German unit labour costs compare favourably with those of her European competitors although manual workers in the German car industry are among the best paid in Europe. Higher real wages in the UK can be achieved through improving productivity with no adverse effects on inflation.

The importance of the relationship between productivity and pay is illustrated by the recent agreement at British Aerospace in Preston where the management believe that they can eventually cut the working week by between 100 and 120 minutes through a simple flexible working arrangement. This involves the staggering of meal breaks to ensure more productive use of capacity; introducing cashless pay (wages paid by the company directly into a bank account); changing shift patterns when required and further eroding job demarcation. Such agreements are encouraging given that our industry level analysis implies that wage flexibility has not been a feature of the UK labour market. In only five sectors, out of the sixteen studied, did we find any sign of wages responding to relative sectoral performance and in only three did we detect the influence of relative productivity on relative pay. Furthermore, in the individual level analysis we saw that although industry wage premiums changed in accordance with the macroeconomic climate, relative industrial wage differentials have been fairly stable. This phenomenon is a consequence of sector-specific characteristics such as workers' bargaining strength or employers' product market power, nonetheless, it is indicative of an inflexible industrial pay structure. However, our comparative framework indicates that this inflexibility is by no means confined to the UK. Our analysis of the relationship between wage flexibility and relative industrial performance undoubtedly can be improved and built upon. In particular, the relationship between productivity, wages, flexible working and the firm's product market power would be an interesting area for further research.

Our findings have interesting implications regarding the influence of fiscal policy on earnings in the UK. A one per cent cut in indirect taxes would have nearly the same effect on real earnings as a one per cent cut in direct taxes. However, changes in employers' taxes do not seem to affect real earnings. This means that increases in, for instance, employers' National Insurance contributions, would be met entirely by the employer thereby increasing the employers' total costs and leading to higher unemployment. Cutting employers' taxes could therefore be an effective method of providing more employment by reducing employers' costs.

We found that industrial mismatch in the economy had a small but significant impact on wages, therefore any measures aimed at improving the mobility of labour, the skill mix or regional imbalances could help to moderate real wages. It must be admitted that our measure of mismatch, which is essentially that of Layard and Nickell (1986), is by no means an ideal measure of the imbalances in the labour market. Further research in this area is needed.

In exploring the dynamics of wage and price inflation we paid particular attention to discriminating between a forward looking rational expectations paradigm and a simple feedback rule based on past prices. Our results favoured the forward looking model of wages which assumes that people form expectations about future price inflation. However, the feedback model withstood econometric scrutiny well, indicating a degree of inertia in the adjustment of real wages for inflation. This inertia means that if price inflation has been high in the recent past, wage settlements would continue to reflect past high prices even though future prices are not expected to continue to rise so fast. This finding does not bode well for the current round of wage negotiations which are conducted in the light of price inflation running at over 10 per cent but with the expectation that price inflation could fall to as low as 5 per cent over the next few years.

Our comparison of wages in the UK to those in France and Germany is particularly relevant in the light of the British decision to join the Exchange Rate Mechanism (ERM) of the European Monetary System (EMS). Although the decision to enter ERM was taken after our work was completed, the comparative framework that we have developed enables us to draw some conclusions regarding the likely impact of the mechanism on the labour market.

The rise in unit labour costs during the latter part of the 1980s was a consequence of falling productivity growth in the UK economy and was accompanied by a depreciation in the value of sterling. This meant that the competitiveness of British exports was maintained. However, full membership of the EMS removes the possibility of using depreciation to improve the short term competitiveness of the UK economy which is being damaged by persistently strong real wage growth.

It is thought, or rather hoped, that firms faced with the discipline of a fixed exchange rate band will resist high wage demands which are not accompanied by comparable rises in productivity. The rate of growth in real wages in the UK would then converge to the lower German level. There are a number of problems with this line of argument. Any change in wage bargaining behaviour is more likely to come in the export manufacturing sector which faces direct foreign competition rather than the domestic service sector of the economy. In 1989 the manufacturing sector as a whole only employed 22 per cent of the work force. Besides, earnings rose more quickly in the service sector than the manufacturing sector. Therefore, even if the discipline of membership of the ERM leads to lower wage inflation in the traded goods sector, it would not immediately affect the whole economy.

In our comparative analysis of wages we noticed that changes in the determinants of wages were slower to feed through to wages in France and Germany, both longstanding members of the ERM, than the UK. Furthermore, we can see from Figures 3.1.1 and 3.1.2 that wage and price inflation in France steadily declined from 1983 when entering the ERM was used to impose discipline on the French economy. By 1989 both price and wage inflation in France were at comparable levels with those experienced in Germany. This is no doubt encouraging for the UK economy; nevertheless, it took six years to achieve. However, some of the results presented in this thesis suggest that the UK will not necessarily follow this pattern without a fundamental re-thinking of labour market policy. Without this, wage inflation could confound policy makers and economic performance for many years to come. Britain suffers from a particular problem: skill shortages.

The work presented in this thesis links wage inflation to skill shortages in a number of respects. For instance, in our study of individual level wages using the Family Expenditure Survey, we discovered that returns to education rose sharply between 1978 and 1985 in Great Britain. Furthermore, we found that changes in the market value of education and certain occupational categories played a significant part in the rise in real wages during this period. Moreover, in our comparative work we found that skill shortages were better at explaining the rise in the UK real earnings in the 1980s than unemployment. This evidence points to a link between wages and skill shortages in the UK. However, in contrast, we found no evidence that skill shortages had an impact on earnings in France and Germany. Our conclusions are by no means definitive, further research in this area being needed, but they are at least illustrative of the importance of the connection between labour market shortages and wage inflation.

Data published after the completion of the research for this thesis indicate that the demand for skills and hence high wage settlements have been continuing in spite of a slowdown in economic activity. The New Earnings Survey (1990) shows that the earnings of bricklayers rose 16.6 per cent on the previous year, building site managers 13.9 per cent and accounting clerks 12.4 per cent, all above the rate of increase in prices. Skilled workers are still at a premium. If a UK exporter, alarmed at the prospect of foreign competition, tries to hold down the wages of skilled workers, it risks the possibility of losing its workforce. A recent survey by the employment agency Manpower (1990) shows that 44 per cent of British employers were experiencing a shortage of skills when unemployment was rising.

Our finding that the returns to education and certain occupational categories have risen is consistent with recent research at the National Institute for Economic and Social Research (1990) which shows that the number of qualified British personnel is much lower than on the European continent. This study makes the link between training and productivity and illustrates that Britain's lack of a trained and qualified workforce has hindered her productivity performance relative to France and Germany. Britain's lack of skilled labour may prevent an early closure of the productivity gap with Germany.

In this thesis we have illustrated the link between skill shortages and wages. However, skill shortages lead to other adverse effects which are worth pursuing in future research. One is the link between skill shortages and investment. Companies who know that the skilled manpower will not be available may refrain from investing for future growth. Of course, they may decide to provide training themselves but they would face 'poaching' by other firms who, instead of providing training, pay higher wages. A classic example of market failure.

The government, alarmed by high unemployment and a poorly trained labour force, has embraced the idea of training. In recent years there have been numerous training programmes primarily aimed at the unemployed: the Community Programme, the Restart Programme and the Youth Training Scheme (YTS). Lehmann (1989) finds that the Community Programme, the Restart Programme and the Enterprise Allowance Scheme had little effect on increasing the number of unemployed people finding work. YTS often does not lead to any formal qualifications and when it does it is often inadequate. NIESR (1990) found that when British teenagers in the clothing industry achieved a certificate after two years on a YTS, they were at the same level that their German counterparts reached after just six months.

What can be done? If skill shortages are a contributing factor to wage inflation then some of the policy prescriptions which have been put forward, such as taxed based incomes policy and job guarantee schemes for the long-term unemployed may not work. The answer will have to be provisions for training.

The current government policy is to put the responsibility for training firmly on the shoulders of industry. The government has initiated the creation of 82 employer-led Training and Enterprise Councils (TECs) which are to eventually take over the publicly funded training schemes such as YTS and Employment Training. The belief is that employers are more aware of their local needs and future requirements. Our time series analysis has shown that skill shortages are not a new phenomenon yet companies have not responded in the past. Recent history shows that if there are no incentives, companies simply do not train their employees. The sort of incentive system that could be introduced might be based upon the German system. In Germany the government usually pays the tuition cost of training and aspiring workers attend in their own time. In Britain the employers are expected to provide training, release workers and foot the bill: too many are unwilling to oblige. There is a need for the government to provide some incentives.

All employers in Germany are legally obliged to release their 16 to 18 year old employees for off-the-job vocational training for at least one day per week. Furthermore, there is a national system to provide uniform qualifications. Although the setting up of the National Council for Vocational Qualifications in the UK has been a step in the right direction, this body has no statutory powers and has so far had limited success. There is no system as yet to provide a national set of qualifications by the newly formed TECs.

In this conclusion we have refrained from restating all the results of our empirical work and have concentrated on the implications of some of the main results for economic policy. The implications of our findings regarding the link between wages and skill shortages are particularly important and timely. Wage inflation in the UK is the highest it has been for several years and, with the formation of TECs, government training policy has been shaped for the foreseeable future.

Many complex forces affect levels of skill and pay and there are several fruitful areas for further research. How far do differences in training contribute to differences in productivity and pay? What is the relationship between pay differentials according to skills and the demand for skills?

A final word of caution is necessary. We are not claiming that training and education form the only key to lower unit labour costs and economic success. However, we do believe that in terms of economic policy, the link between skill shortages and wage determination, which we have demonstrated in this thesis, can be regarded as a link between macroeconomic performance and training. This is a link which has not been fully appreciated before.

Bibliography

Abowd, J.M., (1987), 'Collective bargaining and the division of the value of the enterprise', National Bureau of Economic Research Working Paper no. 2137.

Akerlof, G.A., (1969), 'Relative wages and the rate of inflation', Quarterly Journal of Economics, 83, pp.353-374.

Akerlof, G.A., (1984), 'Gift exchange and efficiency wages: four views', American Economic Review, 74, pp.79-83.

Akerlof, G.A. and Yellen, J., (1987), ' A near-rational model of the business cycle with wage and price inertia', Quarterly Journal of Economics, 100, supplement, pp.823-838.

Alogoskoufis, G., (1990), 'The rise and fall of European unemployment', Birkbeck College, University of London, mimeo.

Alogoskoufis, G. and Manning, A., (1990), 'Tests of alternative wage employment bargaining models with an application to the UK aggregate labour market', Birkbeck College, University of London, mimeo.

Andrews, M.J., (1987), 'Some formal models of the aggregate labour market', Department of Econometrics and Social Statistics, University of Manchester Discussion Paper no. ES184.

Andrews, M.J., (1987), 'Modelling the aggregate labour market: an international perspective', Department of Econometrics and Social Statistics, University of Manchester Discussion Paper no. ES185.

Andrews, M.J., Bell, D.N.F., Fisher, P.G., Wallis, K.F. and Whitley, J.D., (1985), 'Models of the UK economy and the real wage-employment debate', National Institute Economic Review, May, pp.41-50.

Arellano, M. and Meghir, C., (1989), 'Using complementary data sources: an application to labour supply and job search', University College, London. Discussion Paper no. 8906.

Ashenfelter, O.C. and Brown, J.N., (1986), 'Testing the efficiency of employment contracts', Journal of Political Economy, 94, pp.S41-S87.

Ashenfelter, O.C. and Layard, P.R.G., eds. (1986), Handbook of Labor Economics, Amsterdam: North-Holland.

Azariades, C., (1975), 'Implicit contracts and underemployment equilibria', Journal of Political Economy, 83,6, pp.1183-1202.

Baily, M.N., (1974), 'Wages and employment with uncertain demand', Review of Economic Studies, 41, pp.37-50.

Banerjee, A., Dolado, J.J., Hendry, D.F. and Smith, G.W., (1986), 'Exploring equilibrium relationships in econometrics through static models: some Monte Carlo evidence', Oxford Bulletin of Economics and Statistics, 48(3), pp.253-278.

Barro, R.J. and Grossman, H.I., (1971), 'A general disequilibrium model of income and employment', American Economic Review, 61,1, pp.82-93.

Bean, C.R. and Gavosto, A., (1987), 'Capacity shortages and unemployment in the United Kingdom', Centre for Labour Economics Working Paper no. 1025, London School of Economics.

Bean, C.R., Layard, P.R.G. and Nickell, S.J., (1986), 'The rise in unemployment: a multi-country study', Economica, 53,210(S), pp.S1-S22.

Bean, C.R. and Pissarides, C., (1990), 'Skill shortages and structural unemployment in Britain: a (mis)matching approach', London School of Economics, mimeo.

Bean, C.R. and Turnbull, P.J., (1987), 'Employment in the British coal industry: a test of the labour demand model', Economic Journal, 98,393, pp.1092-1104.

Becker, G.S., (1962), 'Investment in human capital: a theoretical analysis', Journal of Political Economy, 70(supplement), pp.9-49.

Becker, G.S., (1964), Human Capital, New York: National Bureau of Economic Research.

Becker, G.S., (1975), 'Human capital, a theoretical and empirical analysis', National Bureau of Economic Research, New York.

Bell, L.A. and Freeman, R.B., (1985), 'Does a flexible industry wage structure increase employment?: the US experience', NBER Working Paper Series no. 1604, National Bureau of Economic Research, Cambridge, Massachusetts.

Bellman, L., (1989), 'Employment measures in the Federal Republic of Germany: their effects on duration specific outflow rates from unemployment', The Employment Institute, mimeo.

Ben-Porath, Y., (1967), 'The production of human capital and the life cycle of earnings, a production approach', Journal of Political Economy, 75, pp.352-365.

Bishop, R.L., (1964), 'A Zeuthen-Hicks theory of bargaining', Econometrica, 32,2, pp.176-188.

Blanchard, O., (1988), 'Unemployment: getting the questions right -- and some of the answers', MIT and NBER, mimeo.

Blanchard, O. and Fischer, S., (1989), Lectures on Macroeconomics, Cambridge MA: The MIT Press.

Blanchard, O. and Summers, L., (1987), 'Hysteresis and the European unemployment problem' in R. Cross et al, eds. Unemployment, Hysteresis and the Natural Rate Hypothesis, Oxford: Basil Blackwell.

Blanchflower, D.G., Oswald, A.J. and Garrett, M., (1988), 'Insider power in wage determination', Centre for Labour Economics Discussion Paper no. 319, London School of Economics.

Booth, A. and Ulph, D., (1988), 'Union Wages and Employment with Endogenous Membership', Bristol University, mimeo.

Bover, O., Muellbauer, J. and Murphy, A., (1988), 'Housing, wages and UK labour markets', Centre for Economic Policy Research Discussion

Paper no. 268, CEPR.

Branson, W.H. and Rotemberg, J.J., (1980), 'International adjustment with wage rigidity', European Economic Review, May, pp.309-322.

Brown, J.N. and Ashenfelter, O., (1983), 'Testing the efficiency of employment contracts', unpublished paper, Princeton University

Browning, M., Deaton, A. and Irish, M., (1985), 'A profitable approach to labor supply and commodity demands over the life-cycle', Econometrica, 53, pp.503-561.

Bruno, M. and Sachs, J., (1984), The Economics of Worldwide Stagflation, Oxford: Basil Blackwell.

Calmfors, L., ed., (1990), Wage Formation and Macroeconomic Policy in the Nordic Countries, Stockholm: SNS Forlag and Oxford: Oxford University Press.

Calmfors, L. and Driffil, J., (1988), 'Centralization of wage bargaining and macroeconomic performance', Economic Policy, 6, pp.13-61.

Card, D., (1986), 'Efficient contracts with costly adjustment', American Economic Review, 76, pp,1045-1071.

Carruth, A.A., (1989), 'The German and UK employment experience, 1970-1988', The Employment Institute, mimeo.

Carruth, A.A., Findlay, L. and Oswald, A.J., (1986), 'A test of a model of union behaviour: the coal and steel industries in Britain', Oxford Bulletin of Economics and Statistics, 48, pp.1-18.

Carruth, A.A. and Oswald, A.J., (1981), 'The determination of union and non-union wage rates', European Economic Review, 16, pp.285-302.

Carruth, A.A. and Oswald, A.J., (1985), 'Miners' wages in post-war Britain: an application of a model of trade union behaviour', Economic Journal, 95, pp.1003-1020.

Carruth, A.A. and Oswald, A.J., (1987), 'Wage inflexibility in Britain', Oxford Bulletin of Economics and Statistics, 49, pp.59-78.

Carruth, A.A. and Oswald, A.J., (1989), Pay Determination and Industrial Prosperity, Oxford: Clarendon Press.

Clark, D. and Thomas, A., (1989), 'Evaluations of labour market policies in the Federal Republic of Germany: a survey', The Employment Institute, mimeo.

Coe, D.T., (1985), 'Nominal wages, the NAIRU and wage flexibility', OECD Economic Studies, 5, pp.87-126.

Coe, D.T. and Gagliardi, F., (1985), 'Nominal wage determination in ten OECD countries', OECD Economics and Statistics Department, Working Paper no.19.

Cuthbertson, K., (1988), 'The demand for M1: a forward looking buffer stock model', Oxford Economic Papers, 40, pp.110-131.

Cuthbertson, K., (1989), 'The encompassing implications of feedforward versus feedback mechanisms: a reply to Hendry', Bank of England, mimeo.

Cuthbertson, K. and Taylor, M.P., (1988), 'A comparison of the rational expectations and the general to specific approach to modelling the demand for M1: a rejoinder', Bank of England, mimeo.

Davidson, J. and Hall, S., (1988), 'Cointegration in recursive systems: the structure of wage and price determination in the United Kingdom', London School of Economics and Bank of England, mimeo.

Davies, G., (1989), 'A decade of Britain's supply side "revolution" - lessons from the past for the future', Evidence to the House of Commons Treasury and Civil Service Committee, Budget Inquiry, 1989, Goldman Sachs, London.

Deaton, A., (1985), 'Panel data from time series of cross-sections', Journal of Econometrics, 30, pp.109-126.

Department of Employment, (1985), New Earnings Survey 1985, London: HMSO.

Department of Employment, (1990), New Earnings Survey 1990, London: HMSO.

Department of Employment, (1986), 'Report on the Census of Production, 1985: Summary Tables, London: HMSO.

Dertouzos, J.N. and Pencavel, J.H., (1981), 'Wage and employment determination under trade unionism: the case of the International Typographical Union', Journal of Political Economy, 89, pp.1162-1181.

Desai, M., (1981), Testing Monetarism, London: Francis Pinter (Publishers) Ltd.

Dickens, W. and Katz, L., (1987), 'Inter-industry wage differences and industry characteristics', in K. Lang and J. Leonard (eds), Unemployment and the Structure of Labour Markets, Oxford: Basil Blackwell.

Dickens, W. and Lang, K., (1987), 'Where have all the good jobs gone?', in K. Lang and J. Leonard (eds.) Unemployment and the Structure of Labour Markets, Oxford: Basil Blackwell.

Disney, R. and Carruth, A.A., (1989), 'The evaluation of 'active' labour market policies', The Employment Institute, mimeo.

Dunlop, J.T., (1944), Wage Determination Under Trade Unions, New York: Macmillan.

Engle, R. and Granger, C.W.J., (1987), 'Cointegration and error correction: representation, estimation and testing', Econometrica, 55, pp.251-276.

Engle, R.F. and Yoo, S.B., (1987), 'Forecasting and testing in cointegrated systems', Journal of Econometrics, 35, pp.143-159.

European Community, (1970-1988), European Community Business Survey, Luxembourg: Commission of the European Communities.

Fischer, S., (1977), 'Long-term contracts, rational expectations, and the optimum money supply rule', Journal of Political Economy, 85, pp. 191-205.

Flanagan, R., (1987), 'Efficiency and equality in Swedish labour markets', in Bosworth, B.P. and Rivlin, A. eds. The Swedish Economy, Washington, DC: The Brookings Institution.

Franz and Konig (1986), 'The nature and causes of unemployment in the Federal Republic of Germany since the 1970s: an empirical investigation', Economica, 53,210(S), pp.S219-244.

Freeman, R.B. and Weitzman, M.L., (1986), 'Bonuses and employment in Japan', National Bureau of Economic Research Working Paper no.1878.

Freeman, R.B., (1988), 'The impact of labor market institutions and constraints on economic performance', Economic Policy, 6, pp.64-78.

Freeman, R.B. and Medoff, J.L., (1984), What Do Unions Do?, New York: Basic Books.

Friedman, M. and Kuznets, S., (1945), 'Income from independent professional practice', National Bureau of Economic Research, New York.

Friedman, M., (1968), 'The role of monetary theory', American Economic Review, 58, pp.1-17.

Gilbert, C.L., (1988), 'Professor Hendry's econometric methodology', Oxford Bulletin of Economics and Statistics, 48(3), pp.283-307.

Gomulka, J. and Stern, N., (1986), 'The employment of married women in the UK: 1970-1983', Taxation, Incentives and the Distribution of Income Programme, Discussion Paper no. 98, London School of Economics.

Gordon, D.F., (1974), 'A neoclassical theory of Keynesian unemployment', Economic Inquiry, 12, pp.431-459.

Granger, C.W.J., (1981), 'Some properties of time-series data and their use in econometric model specifications', Journal of Econometrics, 16, pp.121-130.

Granger, C.W.J., (1983), 'Cointegrated variables and error-correcting models', University of Southern California Discussion Papaer.

Greenhalgh, C., (1980), 'Participation and hours of work for married women in Great Britain', Oxford Economic Papers, 32, pp. 296-318.

Greenhalgh, C.A., Layard, P.R.G. and Oswald, A.J., eds., (1983), The Causes of Unemployment, Oxford: Clarendon Press.

Greenhalgh, C.A. and Stewart, M.B., (1982), 'Occupational status and mobility of men and women', Warwick Economic Research Papers no.211, University of Warwick.

Griliches, Z., (1977), 'Estimating the returns to schooling: some econometric problems', Econometrica, 45, pp.1-22.

Griliches, Z., (1979), 'Sibling models and data in economics: beginnings of a survey', Journal of Political Economy, (Supplement) 87, pp.S37-S64.

Grossman and Hart (1981), 'Implicit contracts, moral hazard and unemployment', American Economic Review, 71, pp.301-307.

Grubb, D., Jackman, R.A. and Layard, P.R.G., (1983), 'Wage rigidity and unemployment in OECD countries' European Economic Review, 21, pp.11-41.

Grubb, D., Jackman, R.A. and Layard, P.R.G., (1982), 'Causes of the current stagflation', Review of Economic Studies, 49(5), pp.707-730.

Hall, S., (1988), 'An application of Johansen's maximum likelihood procedure', Bank of England, mimeo.

Hall, S., (1989), 'Maximum likelihood estimation of cointegrating vectors: an example of the Johansen procedure', Bank of England, mimeo.

Hall, S. and Henry, S.G.B., (1988), Macroeconomic Modelling, Amsterdam: North Holland.

Hart, O.D., (1983), 'Optimal labour contracts under asymmetric information: an introduction' Review of Economic Studies, 50, pp.3-35.

Harvey, A.C., (1981), Econometric Analysis of Time Series, London: Philip Allen.

Haskel, J., (1990), 'Unemployment dynamics in Britain', PhD thesis, London School of Economics and Political Science.

Haskel, J. and Martin, C., (1990), 'The inter-industry wage structure: evidence for Britain', London Business School, mimeo.

Heckman, J., (1976), 'A life cycle model of earnings, learning and consumption', Journal of Political Economy, 84 (supplement), pp.511-544.

Hendry, D.F., (1983), 'Econometric modelling: the consumption function in retrospect', Scottish Journal of Political Economy, 30, pp.193-220.

Hendry, D.F., (1986), 'Econometric modelling with cointegrated variables: an overview', Oxford Bulletin of Economics and Statistics, 48, pp.201-212.

Hendry, D.F., (1988), 'The encompassing implications of feedback versus feedforward mechanisms in econometrics', Oxford Economic Papers, 40, pp.132-149.

Hendry, D.F. and Mizon, G.E, (1989), 'Evaluating dynamic econometric models by encompasssing the VAR', Nuffield College, Oxford University and Southampton University, mimeo.

Hendry, D.F., Neale, A.J. and Srba, F., (1988), 'Econometric analysis of small linear systems using PC-FIML', Journal of Econometrics, 38, pp.203-226.

HM Treasury, (1989), 'Productivity in the 1980s', Economic Progress Report, 201, pp.1-4.

Hicks, J.R., (1963), The Theory of Wages, (1st edn. 1932), London: Macmillan.

Institute of Manpower Studies, (1988), 'Graduate supply and demand into the 1990s', IMS Report 150, University of Sussex.

Jackman, R., (1989), 'A job guarantee for long-term unemployed people' in Making the economy work, J. Shields ed., London: Macmillan and the Employment Institute.

Jackman, R., (1990), 'Wage formation in the Nordic countries viewed from an international perspective', in Calmfors, L. ed., Wage Formation and Macroeconomic Policy in the Nordic Countries, Stockholm: SNS Forlag and Oxford: Oxford University Press.

Jackman, R., Layard, P.R.G., Nickell, S.J. and Wadhwani, S.B., Unemployment, forthcoming.

Jackman, R. and Roper, S., (1987), 'Structural unemployment', Oxford Bulletin of Economics and Statistics, 49,1, pp.9-36.

Johansen, S., (1988), 'Statistical analysis of cointegrating vectors', Journal of Economic Dynamics and Control.

Johansen, S., (1989), 'Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models', Institute of Mathematical Statistics, University of Copenhagen, mimeo.

Johansen, S. and Juselius, K., (1989), 'The full information maximum likelihood procedure for inference on cointegration - with applications', Institute of Mathematical Statistics, University of Copenhagen, mimeo.

Johansen, S. and Juselius, K., (1990), 'Maximum likelihood estimation and inference on cointegration - with applications to the demand for money', Oxford Bulletin of Economics and Statistics, 52,2, pp.169-205.

Joshi, H. and Owen, S., (1981), 'Demographic predictors of women's work participation in post war Britain', London School of Hygiene and Tropical Medicine, mimeo.

Judge, G.G., Griffiths, W.E., Carter Hill, R., Luetkerpohl, H. and Lee, T-C., (1985), 'The Theory and Practice of Econometrics' 2nd ed., New York: John Wiley and Sons.

Katz, L. (1986), 'Efficiency wage theories: a partial evaluation', NBER Macroeconomic Annual, 1, pp.235-276.

Katz, L. and Revenga, A.L., (1989), 'Changes in the structure of wages: the US vs. Japan', Harvard University, mimeo.

Krueger, A.B. and Summers L.H., (1987), 'Reflections on the Inter-Industry Wage Structure' in K. Lang and J. Leonard (eds.) Unemployment and the Structure of Labour Markets', Oxford: Basil

Blackwell.

Krueger, A.B. and Summers, L.H., (1988), 'Efficiency wages and the inter-industry wage structure', Econometrica, 56,2, pp.259-293.

Lang, K. and Leonard, J.S., eds., (1987), Unemployment and the Structure of Labor Markets, New York: Basil Blackwell.

Layard, P.R.G, (1990), 'Wage bargaining, incomes policy and inflation: possible lessons for Eastern Europe', Centre for Labour Economics, University of London, mimeo.

Layard, P.R.G., Barton, M. and Zabalza, A., (1980), 'Married women's participation and hours', Economica, 47, pp. 51-72.

Layard, P.R.G., Metcalf, D. and Nickell, S., (1978), 'The effect of collective bargaining on relative and absolute wages', British Journal of Industrial Relations, 16, pp.287-302.

Layard, P.R.G. and Mincer, J. eds., (1985), 'Trends in women's work, education, and family building', Journal of Labour Economics, 3,1, part 2.

Layard, P.R.G. and Nickell, S.J., (1985), 'The causes of British unemployment', National Institute Economic Review, 111, pp.62-85.

Layard, P.R.G. and Nickell, S.J., (1986), 'Unemployment in Britain', Economica, 53,210(S), pp.S121-S169.

Layard, P.R.G. and Nickell, S.J., (1988), 'The performance of the

British labour market' in R. Dornbusch and P.R.G. Layard (eds), The Performance of the British Economy, Oxford: Oxford University Press.

Layard, P.R.G. and Nickell, S.J., (1986), 'An incomes policy to help the unemployed', in Making the economy work, J. Shields, ed., London: Macmillan and Employment Institute.

Lehmann, H., (1989), 'Employment measures in Britain: their effect on the overall and duration specific outflow rates from unemployment', Centre for Labour Economics, mimeo.

Leontief, W., (1946), 'The pure theory of the guaranteed annual wage contract', Journal of Political Economy, 54, pp.76-79.

Lindbeck, A. and Snower, D.J., (1986), 'Wage setting, unemployment, and insider-outsider relation', American Economic Review, 76, pp.235-239.

Lindbeck, A. and Snower, D.J., (1989), The Insider-Outsider Theory of Employment and Unemployment, Cambridge MA: The MIT Press.

Lipsey, R.G., (1960), 'The relation between unemployment and the rate of change of money wage rates in the United Kingdom 1862-1957: a further analysis', Economica, 28, pp.1-31.

Lipsey, R.G. and Steuer, M.D., (1961), 'Relations between profits and wage rates', Economica, 28, pp.137-155.

Lucas, R.E., (1973a), 'Econometric testing of the natural rate hypothesis' in The Econometrics of Price Determination, O. Eckstein, ed., Washington: Board of Governors of the Federal Reserve System.

Lucas, R.E., (1973b), 'Some international evidence on output-iInflation trade-offs', American Economic Review, 63, pp.326-334.

Lucas, R.E., (1976), 'Econometric policy evaluation: a critique', in The Phillips Curve and Labour Markets, K. Brunner and A.H. Meltzer, eds., pp. 19-46, Amsterdam: North-Holland.

Lucas, R.E. and Rapping, L.A., (1969), 'Real wages, employment and inflation', Journal of Political Economy, 77, pp.257-305.

Lucas, R.E. and Rapping, L.A., (1970), 'Price expectations and the Phillips curve', American Economic Review, 59, pp.342-349.

MaCurdy, T.E. and Pencavel, J.H., (1986),'Testing between competing models of wage and employment determination in unionized markets', Journal of Political Economy, 94, pp.S3-S39.

McDonald, I.M. and Solow, R.M., (1981), 'Wage bargaining and employment' American Economic Review, 71, pp.896-908.

Machin, S., Manning, A. and Meghir, C., (1990), 'Testing dynamic models of employment determination using firm level data', University College, London, Institute for Fiscal Studies and London School of Economics, mimeo.

Malinvaud, E., (1986), 'The rise of unemployment in France', Economica, 53,210(S), pp.S197-S217.

Manning, A., (1987), 'An integration of trade union models in a sequential bargaining framework', Economic Journal, 97, pp.121-139.

Manning, A., (1989), 'Multiple equilibria in the British labour market: some empirical evidence', London School of Economics, mimeo.

Manning, A., (1989), 'Dynamic wage bargaining and staggered contracts', London School of Economics, mimeo.

Manpower, (1990), Survey of Skills Shortages, London: Manpower.

Marsden, D., (1988), 'Institutions and labour mobility: occupational and internal labour markets in Britain, France, Italy and West Germany', London School of Economics, mimeo.

Metcalf, D., (1977), 'Unions, incomes policy and relative wages in Britain', British Journal of Industrial Relations, 15, pp.157-175.

Minford, P. (1983), 'Labour market equilibrium in an open economy', Oxford Economic Papers, 35, supplement, pp.207-244.

Mincer, J., (1962), 'On the job training costs and some implications', Journal of Political Economy, 70 (supplement), pp.50-79.

Mincer, J., (1974), 'Schooling, experience and earnings' National Bureau of Economic Research, New York.

Moghadam, R., (1990), 'Wage determination: an assessment of returns to education, occupation, region and industry in Great Britain', Centre for Economic Performance Discussion Paper 8, London School of Economics.

Moghadam, R. and Pissarides, C., (1990), 'Relative wage flexibility in four countries', in Calmfors, L., ed. Wage Formation and Macroeconomic Policy in the Nordic Countries, Stockholm: SNS Forlag and Oxford: Oxford University Press.

Moghadam, R. and Wren-Lewis, S., (1990), 'Are wages forward looking?', Centre for Labour Economics Discussion Paper no.375, London School of Economics.

Morgan, P.L., (1979), 'Employment functions in manufacturing industry', Government Economic Service Working Paper no. 24, Research and Planning Division, Department of Employment.

National Institute of Economic and Social Research, (1990), Productivity, education and training, London: NIESR.

Newell, A. and Symons, J., (1985), 'Wages and unemployment in OECD countries', Centre for Labour Economics Discussion Paper no. 219, London School of Economics.

Newell, A. and Symons, J., (1987), 'Corporatism, laissez-faire and the rise in unemployment, European Economic Review, 31, pp. 567-601.

Newell, A. and Symons, J., (1988), 'The Phillips Curve is a real wage equation', Centre for Labour Economics Working Paper no.1038, London School of Economics.

Nickell, S.J., (1980), 'Some disequilibrium labour market models: further formalisation of a Muellbauer type analysis' Centre for Labour Economics Working Paper no. 205, London School of Economics.

Nickell, S.J., (1982), 'A bargaining model of the Phillips curve' Centre for Labour Economics Discussion Paper no. 130, London School of Economics.

Nickell, S.J., (1984), 'The modelling of wages and employment' in Econometrics and Quantitative Economics, Hendry and Wallis, eds., Oxford: Basil Blackwell.

Nickell, S.J., (1985), 'Error correction, partial adjustment and all that: an expository note', Oxford Bulletin of Economics and Statistics, 47, pp.119-130.

Nickell, S.J., (1987), 'Why is wage inflation in Britain so high?', Oxford Bulletin of Economics and Statistics, 49, pp. 103-128.

Nickell, S.J., (1990), 'Unemployment in the OECD since 1960' in Jackman, R., et al, Unemployment, forthcoming.

Nickell, S.J. and Andrews, M.J., (1983), 'Unions, real wages and employment in Britain 1951-79', Oxford Economic Papers, 35,supplement, pp.183-220.

Nickell, S.J. and Kong, P., (1987), 'Wages, prices, employment and output in UK industry', Institute of Economics and Statistics, University of Oxford, mimeo.

Nickell, S.J. and Wadhwani, S.B., (1987), 'Financial factors, efficiency wages and employment: investigations using UK micro-data', Centre for Labour Economics Discussion Paper no. 295, London School of Economics.

Nickell, S.J. and Wadhwani, S.B., (1989), 'Insider forces and wage determination', Centre for Labour Economics Discussion Paper no.334, London School of Economics.

Oaxaca, R., (1973), 'Male-female wage differentials in urban labor markets' International Economic Review, 14, pp.693-709.

OECD, (1965), Wages and Labour Mobility, Paris: OECD.

OECD, (1985), Employment Outlook, September, Paris: OECD.

Oswald, A.J., (1985), 'The economic theory of trade unions: an introductory survey', Scandinavian Journal of Economics, 87, pp.160-193.

Oswald, A.J., (1987), 'Efficient contracts are on the labour demand curve: theory and facts', Centre for Labour Economics Discussion Paper no. 284, London School of Economics.

Pagan, A.R. and Nicholls, D.F., (1984), 'Estimating predictions, prediction errors and their standard deviations using constructed variables', Journal of Econometrics, 24, pp.293-310.

Parkin, M., Sumner, M. and Ward, R., (1976), 'The effects of excess demand, generalised expectations and wage-price controls on wage inflation in the UK: 1956-1971', in Brumner, K. and Meltzer, A. eds., The economics of price and wage controls, Amsterdam: North Holland.

Phelps, E.S., (1968), 'Money wage dynamics and labour market equilibrium', Journal of Political Economy, 76, pp. 678-711.

Phillips, A.W.H., (1958), 'The relation between unemployment and the rate of change of money wage rates in the United Kingdom, 1861-1957' Economica, 25, pp.283-299.

Philpott, J., (1989), 'The effects of labour market policies to assist the adult unemployed: an appraisal of British evidence', mimeo.

Pissarides, C., (1978), 'The role of relative wages and excess demand in the sectoral flow of labour', Review of Economic Studies, 45(3), pp.453-467.

Pissarides, C., (1987), 'Wages and employment: a framework for analysis with application to three policy issues', Centre for Labour Economics Working Paper no. 1005, London School of Economics.

Pissarides, C. and McMaster, I., (1984), 'Economy-wide and sector-specific influences on relative wages', Centre for Labour Economics Working Paper no. 571, London School of Economics.

Redpath, R.U., (1986), 'A second study of differential response comparing census characteristics of FES respondents and non-respondents', Statistical News, No. 72.

Rosen, S., (1976), ' A theory of life earnings', Journal of Political Economy, 84(supplement), pp.345-568.

Sachs, (1979), 'Wages, profits and macroeconomic adjustment: a comparative study', Brookings Papers on Economic Activity, 2, pp.269-319.

Samuelson, P. and Solow, R., (1960), 'The analytics of an anti-inflation policy' American Economic Review, 50, pp. 177-194.

Sapsford, D. and Tzannatos, Z., (1990), Current Issues in Labour Economics, London: Macmillan.

Sargan, J.D., (1964), 'Wages and prices in the United Kingdom: a study in econometric methodology' in Econometric Analysis for National Economic Planning P.E. Hart, G. Mills and J.K. Whitaker, eds., London: Butterworths.

Sargan, J.D. and Bhargava, A., (1983), 'Testing residuals from least squaress regression for being generated by the Gaussian random walk', Econometrica, 51, pp.153-174.

Sargent, T.J., (1978), 'Estimation of dynamic labor demand schedules under rational expectations' Journal of Political Economy, 86, pp.1009-1044.

Sargent, T.J., (1979), Macroeconomic Theory, New York: Academic Press.

Shapiro, C. and Stiglitz, J., (1984), 'Equilibrium unemployment as a worker discipline device', American Economic Review, 74, pp. 433-444.

Solow, R., (1979), 'Another possible source of wage stickiness', Journal of Macroeconomics, 1, pp.79-82.

Spanos, A., (1986), Statistical foundations of econometric modelling, Cambridge: Cambridge University Press.

Stern, N., (1989), 'The economics of development: a survey', The Economic Journal, 99, pp.597-685.

Stewart, M.B., (1983), 'Relative earnings and individual union membership in the United Kingdom', Economica, 50, pp.111-125.

Stewart, M.B., (1990), 'Union wage differentials, product market influences and the division of rents', Economic Journal, forthcoming.

Stewart, M.B. and Greenhalgh, C.A., (1982), 'Work history patterns and the occupational attainment of women', Warwick Economic Research Papers no.212, University of Warwick.

Stewart, M.B. and Wallis, K.F., (1981), Introductory Econometrics, Oxford: Basil Blackwell.

Stock, J.H., (1984), 'Asymptotic properties of least squares estimates of cointegrating vectors', Harvard University, mimeo.

Summers, L.H. and Wadhwani, S.B., (1987), 'Some international evidence on labour cost flexibility and output variability', Harvard

University and London School of Economics, mimeo.

Symons, J., 'Some wheezes with inference from panels of countries', Centre for Labour Economics, London School of Economics, mimeo.

Turner, D.S. and Whitley, J.D., (1988), 'The importance of the distinction between long- and short-term employment in UK macroeconomic models', ESRC Macroeconomic Modelling Bureau, University of Warwick, mimeo.

Ulph, A. and Ulph, D., (1989), 'Union bargaining: a survey of recent work', in Sapsford, D. and Tzannatos, Z. eds. Current Issues in Labour Economics, London: Macmillan.

Wadhwani, S.B., (1987), 'The effects of inflation and real wages on employment', Economica, 54,213, pp.21-40.

Wallis, K.F., (1980), 'Economic implications of the rational expectations hypothesis', Econometrica, 48, pp.49-73.

Weiss, Y., (1986), 'The determination of life cycle earnings: a survey' in Ashenfelter, O.C. and Layard, P.R.G. eds. Handbook of Labour Economics, Vol I, Amsterdam: North-Holland.

Wickens, M.R., (1972), 'A note on the use of proxy variables' Econometrica, July, pp.759-760.

Willis, R.J., (1986), 'Wage determinants: a survey and reinterpretation of human capital earnings functions', in Ashenfelter, O.C. and Layard, P.R.G. eds. Handbook of Labour

Economics, Vol I, Amsterdam: North-Holland.

Willis, R.J. and Rosen, S., (1979), 'Education and self-selection', Journal of Political Economy, 87 (supplement), pp.7-36.

Wren-Lewis, S., (1990), 'Nominal inertia and Keynesian effects', National Institute of Economic and Social Research and Centre for Economic Policy Research, mimeo.